316

SENIOR SECONDARY COURSE

GEOGRAPHY

1

National Institute of Open Schooling

NIOS SENIOR SECONDARY - GEOGRAPHY (316) NEW

Complete Textbook (25 Lessons)

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1

NATURE AND SUBJECT MATTER OF GEOGRAPHY

Geography is one of the oldest earth sciences and its roots date back in the works of the early Greek scholars. The word 'geography' was first used by the Greek scholar Eratosthenes in the third century B.C. Geography is made of two words 'Geo' and 'Graphy'. Geo means "Earth" and Graphy means "to describe". Thus, the literal meaning of geography is to describe the earth's surfaces. In other words "Geography is the study of the interaction of all physical and human phenomena and landscapes created by such interactions." It is about how, why, and where human and natural activities occur and how these activities are interconnected. In simple words, the object of geography is to know the earth in its total character including physical, biological and human phenomena interacting with each other. Geography has undergone changes in its approach. The earlier geographers were descriptive geographers. Later, geography came to be developed as an analytical science. Integration of heterogeneous phenomena needs analysis as well as synthesis of multiple factors. Today the discipline is not only concerned with descriptions but also with analysis, synthesis as well as prediction.

In this lesson you will learn how important geography is in everyday life. This study will encourage you to understand your surrounding environment with greater interest. You will also study various approaches, methods and branches to Geography.

OUTCOMES

After studying this lesson, learner:

- describes the use of Geography in daily life;
- traces development of Geography as a discipline;
- explains human-environment relationships and their impacts on each other;
- illustrates the systematic and regional approaches of Geography;

Notes

- explains various analytical techniques in Geography; and
- identifies the different branches of Geography and its scope.

1.1 GEOGRAPHY IN DAILY LIFE

One pertinent question is why should there be such a field as geography? The answer is that this is the only living planet, universe or world in which we live and can directly experience. You must have noticed that the earth's surface is ever changing. In general, the natural features like mountains, rivers, lakes etc. change slowly while the cultural elements like buildings, roads, crops, change fast. Traveling-from one place to another you notice that the number and types of trees change from area to area. All this is because of the changes in factors governing the growth of trees such as climate, soil and terrain and the continuous interaction between the environment in which we live in and the way we use it. The study of Geography is about observing such patterns.

Another aspect of geography is to understand the factors or reason behind the areal differentiation, how social, cultural, economic and demographic factors change our physical landscape and create new or altered landscapes by human interventions. For example, human settlements are the transformation-of forest or barren lands for living purposes by human beings. The features of the earth have a different significance for peoples of different cultures, of different times and of different groups and individuals within the same time and culture.

Geography is often thought of as the art of making and studying maps. Maps give us a much more correct and graphic view of the way the Earth's surface looks compared to a picture of drawing. As earlier, even today geographical information about an area is available through reports, travel diaries and gazetteers. At present maps can be drawn by using satellite images using Geographic Information Systems (GIS) tools. Computers easily convert the information from satellite images into maps to show what changes development can bring about. Such information is of benefit to society. Such mapmakers are in great demand today. Nowadays geographers, engineers, environmental scientists, city planners, social scientists, and many others learn to use GIS to understand the Earth better.

Geography not only investigates what is on the Earth, but also why it is there. Geographers study the location of the activities, carefully identify patterns using maps and find out the reasons for these patterns. The areas are then described based on the distribution of landforms , population, house type and agriculture. They discover the linkages and movements between places and are able to infer the spatial processes that are working in an area.

Today, all over the world there are problems related to providing food security, health, effective energy use and environmental conservation. Equally important are equality issues and sustainable development. All these can be achieved by using our resources in sustainable ways. Study of

geography is, therefore, necessary to learn more about environmental processes and to understand how land use planning can help us to overcome problems.

Geographical thinking and concepts affect our daily decisions in a number of ways– For example when urban master plans are made or rural development strategies are considered, it is important to understand the physical structure, climatic conditions and availability of resources in an area. The decision to shift industries from city areas would require the extension of industrial land use into farming areas. This would displace farmers and their source of income. Similarly, the construction of a railway line or highway causes ribbon development. Many economic activities concentrate along such corridors. Thus, knowledge of geography plays a crucial role in identification of suitable sites for different types of projects with minimum collateral damage to the surrounding environment as well as to the local community. Nowadays, the need to provide relief material to all affected persons after a flood or an earthquake requires a good understanding of the geography of the area. Distribution of relief is functional and related to the needs of people, according to climate or terrain.

Basic Concepts

Geography has been defined differently through different periods of its history. Geographical work in ancient Greece had followed two distinct traditions. One was the mathematical tradition which was focused on fixing the location of places on the earth's surface, and the other was gathering geographic information through travels and field work. According to them, the purpose of geography was to provide a description of the physical features and conditions in different parts of the world. The emergence of regional approach in geography also emphasized the descriptive character of geography. According to Humboldt, geography is the science related to nature and it studies and describes all material things found on earth. The word KOSMOS was used by Humboldt to describe the nature of outer space and earth. He imparted a unifying perspective to the studies of science, nature and mankind. Another important school of thought defined geography as the study of man-environment relationships. The concept of "Erdkunde" by Carl Ritter, "Chorology" by Hettner and "Areal differentiation" by Hartshorne emphasized the regional approach to study geography. It was only after Carl Saur - Hartshorne debate that the use of quantitative methods in geography increasingly accepted and popularized due to which spatial analysis became possible. Subsequently, welfare approach, radical approach, humanistic approach, modernism and postmodernism approaches enriched the studies in geography.

INTEXT QUESTIONS 1.1

1. What is geography?

2. Why is the earth's surface changing?

Notes

3. Who has coined the term 'Geography"?

4. Which are the two distinct traditions followed by Greeks?

1.2 DEVELOPMENT OF GEOGRAPHY

Ancient Period

The earliest records illustrate the interests of scholars in understanding the physical domain of the earth by making maps and astronomical measurements. The Greeks are given the credit of being the earliest geographers, prominent among them being Herodotus, Thales, Aristotle and Eratosthenes.

Pre-Modern Period

This period starting from the middle of 15th century and continuing with the 18th century provides us with enormous information about the physical and cultural nature of the world by the travels and explorations of early geographers. The early seventeenth century witnessed the beginnings of a new scientific geography. Christopher Columbus and Vasco de Gama, Ferdinand Magellan and Thomas cook were important explorers and travelers among those. Varenius, Kant, Humboldt and Ritter led the geographers of this period. They contributed in the development of cartography and discovering new lands, and developing geography into a scientific discipline.

Modern Period

Ritter and Humboldt are frequently referred to as the founders of modern geography. Generally, the latter half of the nineteenth century is considered a period of modern geography. The first modern geographer in the true sense was Ratzel who built the structure of modern geography on the foundations laid down by classical geographers.

Recent Period

The development of geography during the post Second World War period has been very rapid. The American and European geographers such as Hartshorne have contributed the most during this phase. Harthshorne described geography as a science dealing with areal differentiation. The present day geographers look upon regional approach and systematic approach as complementary rather than contradictory.

Scope of Geography

Geography has now acquired the status of science that explains the arrangements of various natural and cultural features on the earth surface. Geography is a holistic and interdisciplinary field of study engaged in understanding the changing spatial structure from past to the future. Thus, the scope of geography is in various disciplines, like armed services, environment

management, water resources, disaster management, meteorology and planning and various social sciences. Apart from that, a geographer can help in day to day life like tourism, commuting, housing and health related activities.

1.3 APPROACHES FOR STUDY OF GEOGRAPHY

Today, geography is the only discipline that brings all natural and human sciences on a common platform to understand the dynamics of the spatial configuration of the earth surface. There are two main approaches in geography:

A. Systematic

B. Regional

Systematic Approach

A study of specific natural or human phenomenon at world scale that gives rise to certain spatial patterns and structures on the earth surface is called systematic study. This approach was given by Humboldt, a German geographer (1769-1859). Ordinarily, systematic geography is divided into three main branches. Additionally, philosophy of the subject and use of quantitative techniques helps in understanding the subject and analysis and synthesis of the phenomena respectively.

Main branches of systematic geography;

- Physical geography
- Human geography
- Biogeography, including environmental geography
- Methods and Techniques in Geography

a. Physical geography

It deals with earth systems like atmosphere (air), the hydrosphere (water), the lithosphere (earth solid rock) and biosphere, which encompasses all of earth's living organisms. Astronomy, geomorphology, climatology, oceanography, hydrology, water resources and soil geography are the sub-branches of physical geography. Let us discuss some of the branches in brief.

b. Human geography

It describes population and dynamics of social, economic, and political aspects of space. The Sub branches includes; Population geography, Settlement geography, Economic geography, Resource geography, Agriculture geography, Industrial geography, Social and cultural geography, Geography of health, Political geography, Transport geography and Historical geography.

Notes

c. Biogeography and environment geography

It focuses on evolution and distribution of plants (flora) including grasslands and forest and animals (fauna), ecosystems and environment. Focus is on processes, types, distribution, human- nature relationships and the quality of the living environment including the elements of water, air and noise pollution, solid waste and waste water management.

d. Geographical methods and techniques

It deals with methods and techniques for field studies, qualitative, quantitative and cartographic analysis and use of Geographic Information System (GIS), Global Positioning system (GPS) and remote sensing for mapping, modeling and spatial analysis.

Regional Approach

Vidal de la Blache, Carl Ritter, Alfred Hettner and Richard Hartshorne were the prominent geographers who advocated a regional approach in geography. Unlike systematic approach, regional approach starts with the spatial imprints of one or all the systematic geographic processes discernible as regions of different sizes. Regions could be based on a single factor like relief, rainfall, vegetation, per capita income etc. They could also be multifactor regions formed by the association of two or more factors. Administrative units like states , districts, tehsils also can be treated as regions. The main sub branches of regional geography are:

- Regional studies
- Regional planning
- Regional development
- Regional analysis

Regional studies: It refer to the study of a region. It comprises Macro or large scale like the whole world or a country, Meso or medium scale like a region such as Chota Nagpur Plateau and Micro or small scale like a village, tehsil or a district.

Regional planning: It is planning of a region at different scales, country/ rural or urban.

Regional development: It is the execution of regional plan i.e development of a region at different scale/size.

Regional analysis: It refers to description, analysis and synthesis with a regional approach to understand the spatial disparities in development.

INTEXT QUESTIONS 1.2

1. Which are the main branches of systematic geography?

2. Name the main branches of regional geography.

1.4 METHODS AND TECHNIQUES OF GEOGRAPHY

Each branch of systematized knowledge has certain methods / tools and techniques on which it depends to further its basic objectives. Geography too has its tools, techniques and methods. Important among them are globes, maps, diagrams, relief models and spatial analytical methods. Cartography is concerned with preparation of maps and diagrams to show distribution of geographical phenomena. Important methods in geography are deductive and inductive in nature. Various statistical techniques and models are used for regional analysis and to understand spatial distribution and interaction.

a. Cartography

Most of us are fascinated with maps. "Cartography" is the study and practice of making maps and diagrams. It represents the earth with maps and abstract symbols. Maps have traditionally been made using pen, ink and paper, but computers have revolutionized cartography and with GIS methods one can prepare maps and diagrams with greater choice and efficiency.

Spatial data is obtained from measurement and other published sources and can be stored in a database, from which it can be extracted for a variety of purposes. Current trends in this field are moving away from drawing with ink or paper type methods of map making towards the creation of increasingly dynamic, interactive maps that can be manipulated digitally. Most commercial quality maps are now made with map making software that falls into one of three main types; Computer aided data management (CAD), Geographic Information Systems (GIS) and Global Positioning Systems (GPS).

Cartography has grown from a collection of drafting techniques into an actual science. Cartographers must understand which symbols convey information about the Earth most effectively, and make such maps that will encourage everyone to use the maps to find places or use it for their daily work. A cartographer must learn geodesy and fairly advanced mathematics to understand how the shape of the Earth affects the distortion of map symbols projected onto a flat surface for viewing.

"Geographic Information Systems" deals with the storage of information about the Earth for automatic retrieval by a computer in an accurate manner. In addition to other sub disciplines of geography, GIS specialists must understand computer science and

database systems. Maps have traditionally been used to explore the Earth and to exploit its resources. GIS technology, as an expansion of Cartographic science, has enhanced the efficiency and analytic power of traditional mapping. Now, as the scientific community recognizes the environmental consequences of human activities, GIS technology is becoming an essential tool in the effort to understand the process of global change. Various map and satellite information sources can combine in ways that recreate the interactions of complex natural systems. Such visualization can help to predict what will happen to an area if it is repeatedly flooded, or what changes are expected if a particular industry is located or developed in an area.

Survey of India, inherited from the British Ordnance Survey, the NATMO is a premier organization for mapping in India. Its maps of one million series are well known. The organization of the Cartographic Unit in the 1960s at the French Institute, Pondicherry, brought a significant impact on the development of Geography in India. Its publication of Vegetation and Soil maps at the scale of 1:100000 were very well received for their cartographic appreciation and resource mapping. This Unit was upgraded in 1995 as a Genetics Laboratory with an emphasis on computer cartography and GIS.

b. Quantitative methods in Geography

These aspects of geographical techniques deal with numerical methods most commonly found in geography. In addition to spatial analysis, you are likely to find methods like cluster analysis, discriminant analysis in geographic studies. These statistical techniques are useful in finding patterns and identifying relationships between space and the activities that are performed in them.

c. Field Survey and Methods

Geographic research is based on both secondary and primary data. There are different types of surveys based on questionnaire or schedule and focused group discussion. Survey can cover all the inhabitants of the area (Census) or a small part of the total (sample survey).

1.5 BRANCHES OF GEOGRAPHY

Branches of Geography can be categorised in two broad groups:

Physical Geography

a. **Astronomical Geography:** It studies the celestial phenomena which concern the Earth's surface particularly Sun, Moon and Planets of the Solar System.

b. **Geomorphology:** It is concerned with the study of the landforms on the Earth's surface. It includes origin and development of landforms through erosional, transportational and

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depositional processes of water, wind and glaciers.

c. **Climatology:** Climatology is the study of the atmospheric conditions and related climatic and weather phenomena. It includes the study of atmospheric composition, climatic regions, seasons, etc.

d. **Oceanography:** It is concerned with the study of various types of Oceanic components and processes related to ocean floor depths, currents, coral reefs, and continental drifts etc.

e. **Soil Geography or Pedology:** It studies various soil forming processes, their physical, chemical and biological constituents, their color and types, texture, distribution and carrying capacity etc.

f. **Hydrology and water resources:** It comprises the study of all water bodies such as sea/oceans, rivers, lakes and elements of rainfall and snowfall (precipitation), and glaciers.

g. **Biogeography and environment geography:** It focuses on evolution and distribution of plants (flora) including grasslands and forest and animals (fauna), ecosystems and environment. Focus is on processes, types, distribution, human- nature relationships and the quality of the living environment including the elements of water, air and noise pollution, solid waste and waste water management.

Human Geography

a. **Anthropogeography:** It largely deals with racial phenomena in their spatial context.

b. **Cultural geography:** It focuses on the origin, components and impact of human cultures, both material and non-material over space. It comprises landscape characteristics, in terms of caste, race, religion, dialect and language, art and craft, literature, folk dance and music, cuisine and social norms and behaviors; its pattern and diffusion.

c. **Social geography:** It is the analysis of social phenomena in space. Poverty, health, education, livelihood are some important fields of study in social geography.

d. **Geography of Health:** It is a sub-branch of social geography which deals with issues related to mortality, morbidity (disease), and immunization etc. in its spatial context.

e. **Population geography:** It is the study of various dimensions of population such as demographic (population distribution, density, composition, fertility, mortality, migration) and socio-economic characteristics.

f. **Settlement geography:** It is the study of Rural/Urban settlements, their size, distribution, functions, hierarchy, and various other parameters of the settlement system. Nowadays, urban geography and rural settlement are taught as separate branches of human geography.

g. **Economic geography:** It refers to the study of the location and distribution of economic activities at the local, regional, national and world scale. Economic geography can be studied under the following heads: resource geography, agricultural geography, industrial and transport geography.

h. **Resource geography:** It is defined as the study of the distribution and characteristics of resources, which distinguish one region from another, with interest focused on utilisation,

i. **Agriculture geography:** It focuses on cropping pattern, production and trade, input of agriculture, irrigation and marketing of products.

j. **Industrial geography:** It studies types of industries, their growth, spatial pattern, input and production and industrial policies.

k. **Transport geography:** It studies the transport network, accessibility and related issues.

l. **Political geography:** It is the study of political phenomena such as boundaries, geopolitical issues, delineation of constituencies and electoral issues in their spatial context. Main focus remains for creation and transformation of political and administrative regions

m. **Historical geography:** Spatial and temporal trends of geographical phenomena are studied in historical context.

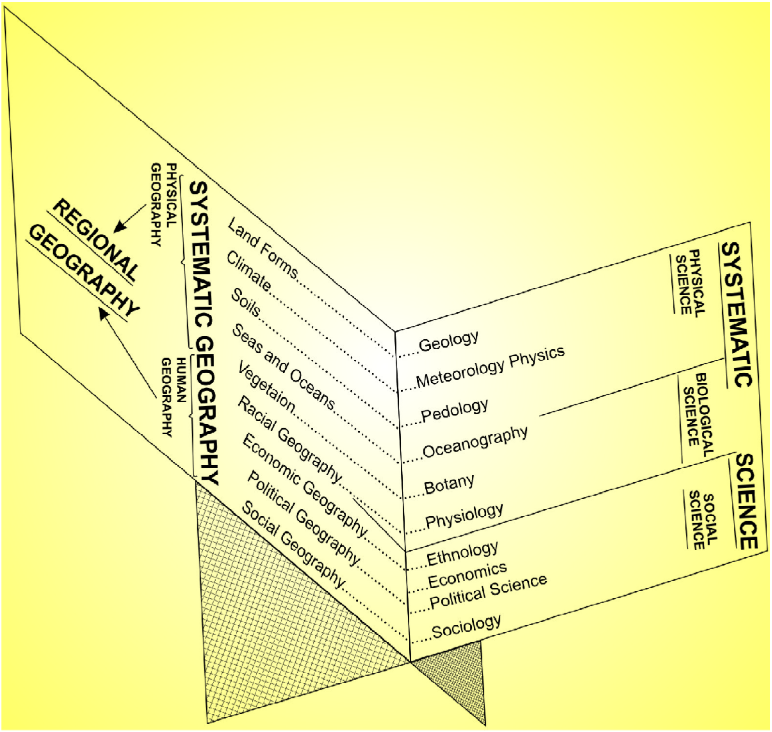


Fig. 1.1 Geography as an integrating science (Based on Hettner and Hartshorne)

1.6 GEOGRAPHY AS AN INTEGRATING DISCIPLINE

Geography is a peculiar discipline in the sense that it focuses on the integration of heterogeneous phenomena. Geography has its strong relation with mathematics, natural sciences, and social sciences. Geomorphology is closely related to geology and geophysics; oceanography and water resources with meteorology and hydrology; soil geography with agronomy; economic geography with economics, social/cultural geography with sociology; anthropogeography with anthropology, political geography with political science, environment geography and biogeography with botany and zoology. While other sciences deal with distinctive types of phenomena, geography studies several kinds of phenomena, each already studied by other sister disciplines. In an integrated manner thus, geography has firmly established itself as a discipline of synthesis. Fig. 1.1 gives the idea of integrating science

INTEXT QUESTIONS 1.3

1. What are the two branches of geography?
2. Name the tools and techniques of geographical study?
3. What is Anthropogeography?
4. What is the difference between social and cultural geography?
5. Why is geography considered an integrating discipline?

WHAT YOU HAVE LEARNT

- Geography is a science of space. Geography is both a natural and social science as it studies both the environment and the people. It is concerned with the different ways in which resources are used. It connects the physical and cultural world. Physical geography studies the earth systems that create natural environments.
- Earlier geography merely described places. Even though this is still a part of geography, the pattern of description has changed a lot in recent years.
- Geographical phenomena and processes are generally described by two approaches viz. (i) regional and (ii) systematic. Regional approaches are characterized by understanding the formation and characteristic of regions.
- Systematic approach is organized in terms of particular phenomena of general geographic significance. Each phenomena is studied in terms of the relations of its areal differentiations with the others.

Notes

- Geography has two main branches: Physical and human. Physical geography is further subdivided into several other branches namely geomorphology, climatology, oceanography, soil and biogeography.
- Human Geography is also subdivided into other branches like, cultural, population, social, economic and political.

TERMINAL QUESTIONS

1. Define the term 'Geography'.
2. Why geography is called the mother of all sciences?
3. What are the two basic approaches in geography?
4. What are the four phases of development of geography?
5. Define the terms physical and human geography.
6. Why is human geography an important part of geography? Explain with suitable examples.
7. Distinguish between the followings:

   i. Systematic and regional geography.

   ii. Physical geography and human geography.

   iii. Population and economic geography.

   iv. Discuss the techniques of geographical studies.

ANSWERS TO INTEXT QUESTIONS

1.1.

1. Geography is largely the study of the interaction of all physical and human phenomena and landscapes created by such interactions.
2. The Earth's surface is changing because of the continuous interaction between the environment in which we live in and the way we use it.
3. Eratosthenes

Notes

4. (a) Mathematical tradition,

   (b) Geographic information through travel and field work.

1.2

1. (i) Physical Geography

   (ii) Human Geography

   (iii) Biogeography

   (iv) Geographycal methods and teaching

2. (i) Regional studies

   (ii) Regional analysis,

   (iii) Regional development and

   (iv) Regional planning.

1.3

1. (i) Physical

   (ii) Human

2. (i) Quantitative methods

   (ii) Remote sensing/ GIS/GPS

   (iii) field survey methods

3. It deals largely with racial phenomena in their spatial context.

4. While other sciences deal with distinctive types of phenomena, geography studies several kinds of phenomena, each already studied by other sister disciplines. Thus in an integrated manner, geography as a discipline, analyses and synthesizes knowledge from diverse fields.

MODULE -2

Dynamic and Geomorphic Processes of the Earth

2. Endogenic Forces
3. Exogenic Forces and their Resultant landforms
4. Running water, moving ice, wind and sea waves

2

ENDOGENIC FORCES

You have already studied about the development of geography, its themes as well as different branches. This lesson belongs to the branch – Geomorphology. Your book laying on the table will remain there until you or someone else remove or shift it by applying some force. Only then the book's position will change. Its position may also change when the table itself is moved by any force. Movement of tables is caused due to internal mechanisms. Your hand is an external force which removes the book. Therefore, there are two types of forces – Internal and External. All the features observed on earth's surface are the results of the balance between these two types of forces. These forces are dependent upon numerous factors. Hence, it is necessary to understand the interior of the earth and internal forces in operation. Due to internal forces, the surface with sizable thickness is always on move. In this context, we will study the continental drift and its improvised version of plate tectonics. Its results like folds, faults and earthquakes are also there to study in this lesson.

OUTCOMES

After studying this lesson, learner:

- explains changing temperature, rocks density, and state of matter in the interior;
- identifies endogenic forces shaping the earth;
- explains continental drift and mechanism of plate movement;
- describes fold, fault, their types their formation, and
- explains the causes, occurrences and spatial distribution of volcanoes and earthquakes.

2.1 EARTH'S INTERNAL FORCES

The features seen on earth's surface are the result of two types of forces – Endogenic (internal) and Exogenic (external). The forces which are generated from below the earth's surface are termed as endogenic forces. Forces which are operational on or above the earth's surface are known as exogenic forces. In this lesson, we are going to discuss Endogenic forces, while the exogenic forces will be covered in the next lesson.

You might be knowing that the temperature in the interior goes on increasing if we go from the earth's surface. Increase in temperature leads to expansion among rock molecules. Heat is transferred from the higher temperature to lower temperature areas. Since the temperature towards surface is lower in comparison to the internal parts, the dissipation of heat is possible only towards surface. In the process of heat transport, conventional current is produced. Once convection currents are created, it causes numerous changes.

2.2 EARTH'S INTERIOR

You might have watched volcanic eruptions on television or in movies. Huge amounts of molten material, dust particles, smoke and flame come out from the mouth called crater. In that way, we receive some internal materials on the earth surface. Beyond the depth of volcanic origin, there is no availability of materials on the earth surface for direct observation and analysis. The average radius of the earth is about 6371 km. Our reach in the interior is confined to the depth of mining and drilling. The material from that depth is available to us for study. Therefore, to know the interior, we have to take the help of different sources.

A. Sources to Study Earth's Interior

Primarily, there are two types of sources by which we try to know the interior. They are Direct sources and Indirect sources.

a. **Direct Sources:** It is that source in which we get the materials from the interior into our hands. The material from the interior is available through mining, drilling or volcanic eruption.

i **Mining** : For a very long time, mining has been done at several places all over the globe. In mining, we dig the earth surface and extract ores or needed matter. Hence, we get the matter from below the surface into our hands. But the mining is confined to a little skin depth of earth's interior. Gaut gold mine of South Africa is the deepest. Its depth is around 3.8 km from the surface. With respect to the earth's radius, it is negligible.

ii. **Drilling :** Further deep materials are also brought to the surface by drilling. The deepest drilling has been recorded at north-eastern part of the Scandina-

vian landmass on Kola Peninsula in Russian territory. Its depth is more than 12.2 km from the surface. It is also very small in depth and not able to tell about the deep internal parts.

iii. **Volcanic Eruption :** Volcanic erupted materials are ejected from a much deeper part of the earth's interior. The exact deepest origin of the volcano is not known but it is also not very significantly deep in comparison to the earth's radius. Hence, it is also not of great importance to know the deep interior.

b. **Indirect Sources** The meaning of the term 'indirect' is quite obvious. It includes those sources which are studied based on certain scientific principles and investigations. The study of rock density, pressure and temperature at different depths are included. Let us study these sources.

i. **Density :** A rock is composed of a mineral or many minerals. The characteristics of minerals determine the nature of rock. The density of the rock is the property of rock's compactness. Density is defined as the relationship between the mass of the rock and how much volume it occupies. Thus, a rock with greater mass and lesser volume will become denser, whereas less mass with greater volume will lead to lesser density.

ii. **Pressure :** The rock of the interior is more compressed due to overlying rocks. Initially, it was believed that rocks of the interior are denser due to compression. But it is also scientifically proved that the density of the rock cannot be increased simply by compression or pressure beyond a certain limit.

iii. **Temperature :** It is observed that the temperature is increasing in the interior. The increase is about 3° Celsius per 100 meter (or about 30 degree Celsius per km) of depth in the top layer only. This rising trend of temperature is not maintained for much deeper. On the basis of recent experiments, geo-scientists have calculated the temperature of the core to be around 5000° Celsius with a variation of around 500° Celsius.

Relationships of Density, Pressure and Temperature with Depth

From the discussions made above, it is quite clear that all the three components are increasing with increasing depth. Their increase is not uniform continuously but with changing rates. Their relationships can be seen in given Figure.

Relationships of Density, Pressure and Temperature with Depths in the Earth's Interior

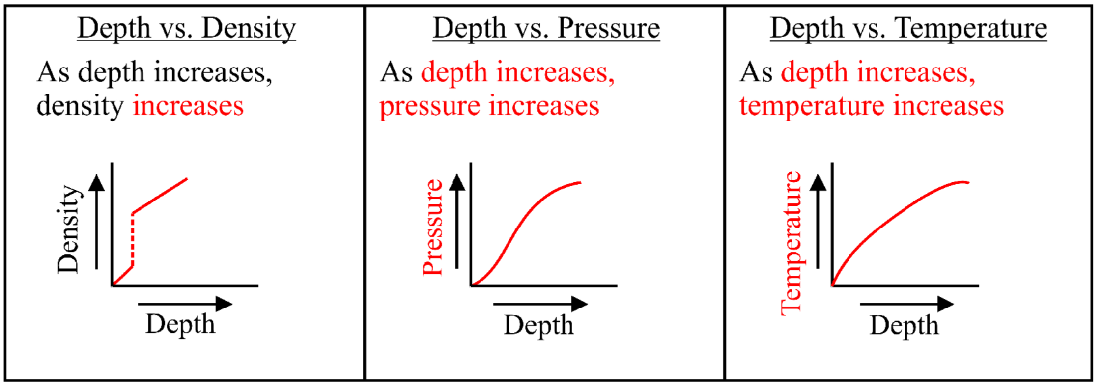


Fig. 2.1: Density, Pressure and Temperature with Depths

INTEXT QUESTIONS 2.1

1. The sources to know about the earth's interior are: (a)............... (b) ....

2. The temperature increase in the upper crust is .... C. Per Km.

B. Seismology and Earth's Interior

Seismology is a branch of scientific knowledge to study the earthquake and its waves propagated through different parts and depths of the earth. An earthquake is a sudden vibration or shake of the ground of an area due to abrupt movement of landmass. This leads to earthquake waves. They are recorded by an instrument commonly known as seismograph.

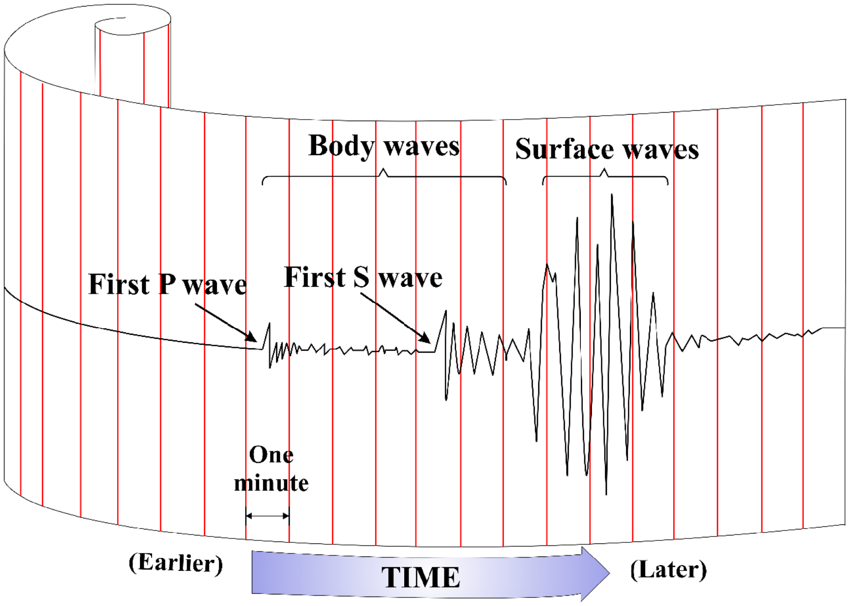


Fig. 2.2: An Ideal Seismograph

Notes

It is important to mention here that seismology is the only source by which the entire earth could be scanned. The scanning provides authentic and complete information about all parts and depths of the earth. Earthquakes originate from a depth below the earth surface. This depth could be anything from a few meters to hundreds of km.

The point from where the earthquake originates is known as focus (Figure 2.3). The shortest distance from focus to earth's surface (perpendicular distance exactly above from focus), is referred to as epicenter. Epicenter, being the closest place on the earth's surface, experiences the earthquake first. It is recorded later to places away from the epicenter. Principally, there are three types of seismic waves – Primary (P), Secondary (S) and Surface (L) waves which are recorded one after the other by the instrument.

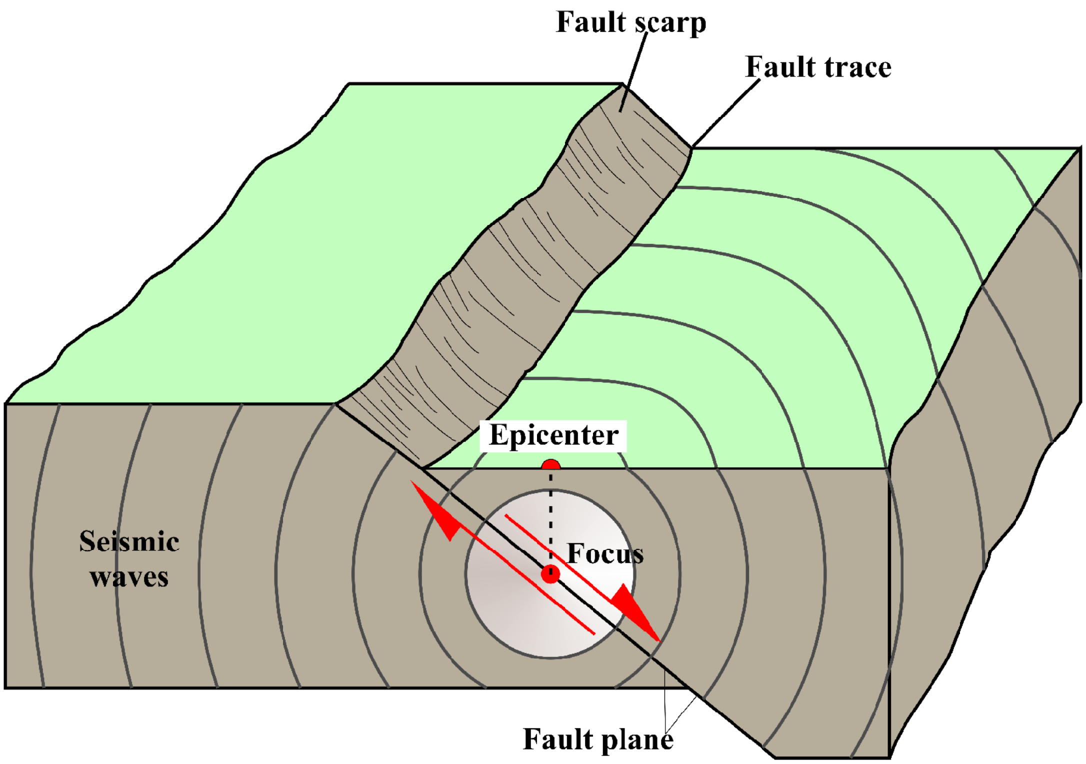


Fig. 2.3: Diagrammatic Presentation of Seismic Wave Propagation

Primary (P), Secondary (S) and Surface/Long (L) Waves

Primary (P) waves are known as compressional waves. They are also termed as push and pull waves. It is like sound waves that we hear. Secondary (S) waves are known as transverse waves. These waves travel at right angles to the direction the wave propagation. These waves seem to be like the light waves. Surface waves travel through the earth's surface with a large distance. Hence, they are also known as long (L) waves. In fact, surface waves are a combined display of the P and S waves. The characteristics of these waves are given in Table 2.1.

Table 2.1: Characteristics of Seismic Waves

Primary (P) Waves	Secondary (S) Waves	Surface/ Long (L) waves
Fastest wave and reaches first at the surface. Travels in solid, liquid and gas medium of matters. High velocity is in solid, becomes less in liquid and very slow in gas state of matter. Increase in density of rocks, velocity increases and vice versa. Change in the state of matter from solid to viscous or liquid, its velocity decreases even if the density is more. Velocity of P waves varies from 5.5 km per second at or near the surface to 13.0 km per second in the deep interior.	Its velocity is lesser than Primary (P) waves. So it is recorded after P waves on the seismograph. Travels only through the solid state of matter. Increase in density of rocks, velocity increases and vice versa. Once the state of matter changes from solid to viscous, its velocity is reduced. But when the rocks are melted, it disappears completely. Velocity of S waves varies from 3.25 km per second at or near the surface to 7.0 km per second in the interior.	Its velocity is lesser than P and S waves. So, it is recorded after P and S waves on the seismograph. Travels only through the solid state of matter. Velocity varies from 2.0 to 4.4 km per second.

a. Seismology and Constitution of the Earth's Interior

The waves generated at the time of the earthquake radiate in all directions. They are along curved paths. Curvature of the paths is due to changing density from the earth's surface to the core. Due to refraction of the waves, S waves are not found beyond an angular distance of 105^0 from the epicenter of the earthquake. In the same way, P waves are not traceable from 105^0 to 140^0 from the epicenter of the earthquake. These are known as shadow zones.

The interior of the earth is revealed by the nature of the propagation of P and S waves. Approximately at an average depth of 40 km, there is sudden increase in the velocity of both waves which suggests sudden increase in density of rocks.

Notes

At a depth of around 100 to 250 km, the velocity of both waves starts declining and after around 700 km velocity again becomes higher. Decreasing velocity between these depths indicate that the matter of rocks is semi-solid. Because of this the velocity of both waves declines. This low velocity zone is known as the nosphere. It is also named as the transition zone.

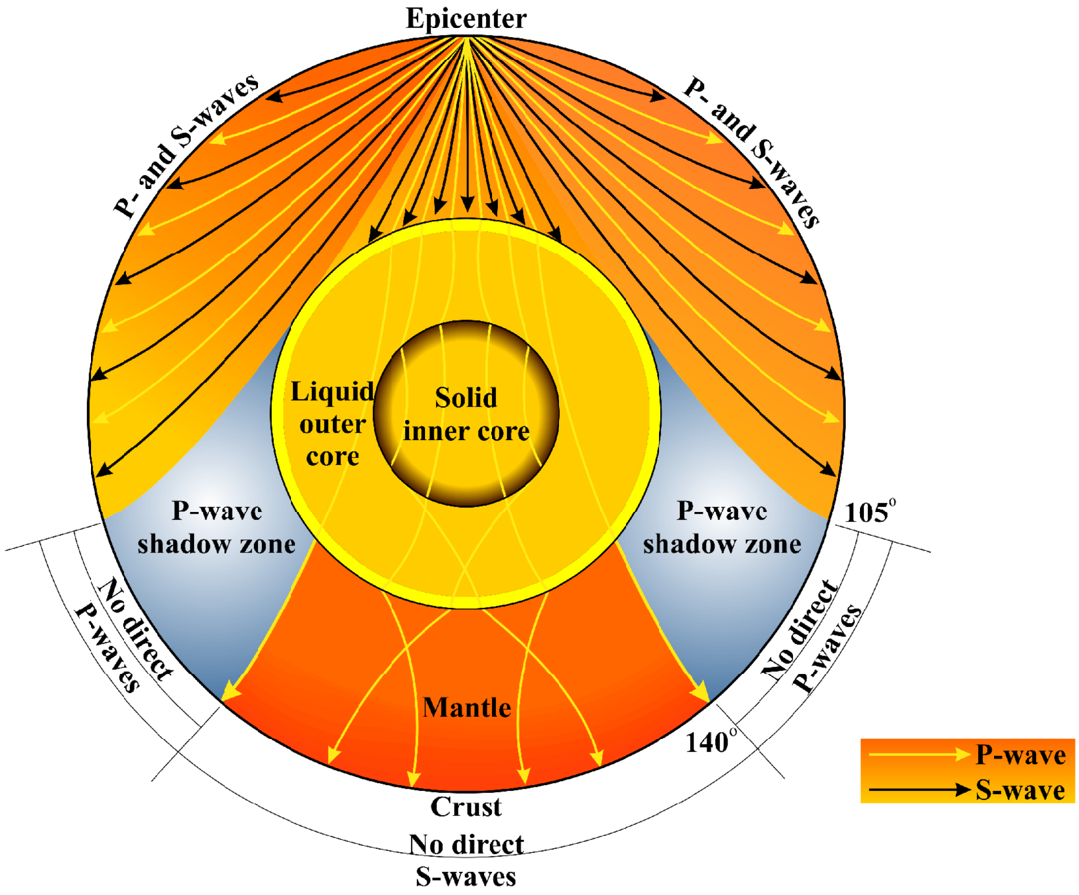


Fig. 2.4: Propagation of P and S Waves in the Interior

Further the velocity of both waves increases continuously until a depth of 2900 km. Increasing velocity shows that the density is higher and the state of the rocks is solid. From 2890 km to 2900 km, the rocks are again almost in a plastic state, i.e., neither solid nor liquid. It is termed as Gutenberg discontinuity.

Beyond the depth of 2900 km, there is no trace of S waves and the velocity of P waves declines very drastically. The rock at this depth is melted and the S wave does not travel in liquid. Reduction in the velocity of P waves is also due to the changing state of the matter or rocks. At around 5150 km depth, the velocity of the P waves increases. This is proof that the rocks become solid again.

Notes

INTEXT QUESTIONS 2.2

1. Name the earthquake measuring instrument.
2. 'P' waves travel in .... layer/layers and 'S' waves travel in .... layer/layers.

b. Chemical Composition of the Earth

There are three major and almost concentric layers in the earth. These are explained by Swiss and they are SIAL, SIMA and NIFE.

SIAL: It is the topmost layer of the earth found just below the sedimentary thin cover of the crust. Silicon (Si) and Aluminum (Al) are the two very important elements found in abundance in this layer and so they are named as SIAL. The average density of this layer is 2.75 to 2.90 g/cm^3 and its average depth is 40 km. It is very thin below the oceanic bed (5 to 10 km) but below the mountains, it is very thick (up to 70 km). The main rock occupying here is of granite types.

SIMA: It is the second layer after SIAL from the surface. It is named after Silicon (SI) and Magnesium (MA) as both of these elements are very much abundant in this layer. It is a very thick layer which goes almost up to 2900 km depth. Below the continents, it starts from an average depth of 40 km while below the oceans, it is found at about 0 to 5 km depth. Its average density varies from 2.90 g/cm^3 to 4.75 g/cm^3. The main rocks in this layer are silicates of magnesium and iron. This layer is largely composed of basalt.

NIFE: It is the innermost layer of the earth. This layer is made up of Nickel (NI) and Ferrous (FE) and so it is named as NIFE. It is just below the SIMA from a depth of 2900 km to the earth's centre. Nickel and Ferrous are very heavy and dense elements and therefore this layer has higher density. Its density is about 11 to 12 g/cm^3.

c. Earth's Internal Structure

The study of the propagation of seismic waves in the interior enabled the scientists to theorize about its structure. Based on the abrupt changes in the paths of seismic waves, the structure of the earth has clearly been demarcated into three zones. They are Crust, outer and a very thin layer including our earth surface; Mantle, an intermediary layer thick with large volume of rocks below the crust; Core, the innermost layer which is spread all-around the center of the earth.

Notes

i. **The Earth's Crust:** The earth's crust is the outermost and the thinnest layer with an average depth of 5 km below oceans and 40 km below the continents. Its depth reaches about 70 km below the mountains. Apart from a very thin sedimentary layer on the continental crust and adjoining ocean floors, it is primarily composed of igneous and metamorphic rocks. The density of the crust at the surface is 2.7 g/ cm^3 and at the bottom limit, it is 2.9 g/cm^3. The demarcating limit is known as Mohorovicic (Moho) discontinuity from where mantle starts.

ii. **The Mantle :** Just after the upper layer, i.e., crust, the density of the mantle at the boundary increases to 3.0 g/cm^3. It extends from the base of the crust to about 2900 km below the surface and occupies over 80% of the earth's volume and 65% of the total mass. Mantle is composed of ultramafic rocks which are igneous in nature and very rich in minerals constituting magnesium and iron with very low silica content. Roughly up to a depth of 100 to 250 km from the surface of the earth, the rocks are firm, solid and rigid. It is termed as lithosphere. Below this depth, the state of the matter is partially molten and plastic in behaviour. This plastic and semi-solid belt extends about a depth of 700 km. It is known as the asthenosphere from this depth to about 2900 km. the state of rock is rigid and solid. It is termed as mesosphere.

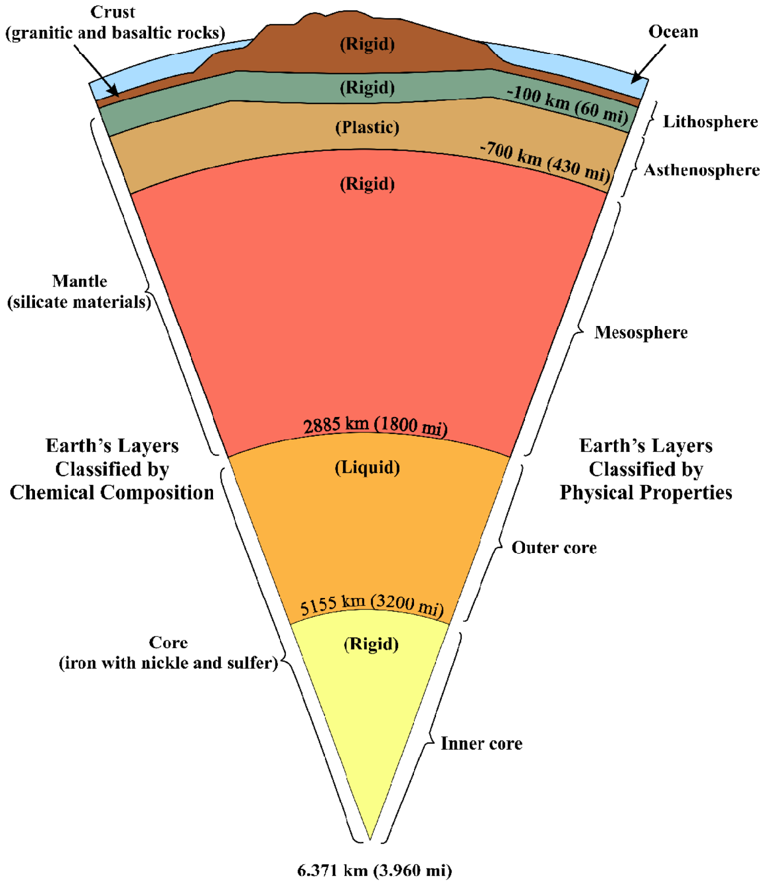


Figure 2.5: Earth's Internal Structure

iii. The Core : It is the innermost layer of the earth starting from 2900 km to the centre (6371 km). It has a volume of only 17% of the earth but it contains 34% of the mass. It is because of the very high dense materials lying over there. The density of the core at the outer boundary is about 10 g/cm^3 and in the innermost part it is $13 g/cm^3$. The core is made up of iron and nickel. It is divided into layers upper and lower.

INTEXT QUESTIONS 2.3

1. Name different layers of earth explained by Swiss.
2. Earths core starts from .... km.

2.3 CONTINENTAL DRIFT

As the term itself is self-explanatory – "continental drift". It means continents are drifting or shifting their positions with passage of time.

Alfred Wegner was first to introduce the concept of Continental Drift in a detailed and comprehensive manner in 1912. He was a German meteorologist and geophysicist and was studying the distribution of plants over the globe. During his study, he was trying to study the plant's fossils underlying in the sedimentary rocks of the east and west coasts of the Atlantic Ocean. He came across the similarity between the two coasts in terms of plant fossils and geology. On the basis of this study, he proposed the concept of continental drift.

According to Alfred Wegener, the entire landmass of the globe was together about 200 million years ago. He termed it Pangea, a super continent of the beginning. The huge water body surrounding the Pangea was known as Panthalasa. About 135 million years ago, Pangea was broken latitudinally into northern and southern parts known as Laurasia (Angaraland) and Gondwanaland, respectively. Both of them drifted away and in between a shallow sea emerged by filling up the water from Panthalasa. It was known as Tethys Sea. Later on Laurasia and Gondwanaland were rifted and finally drifted to form the present day distribution of land and water on the earth.

Notes

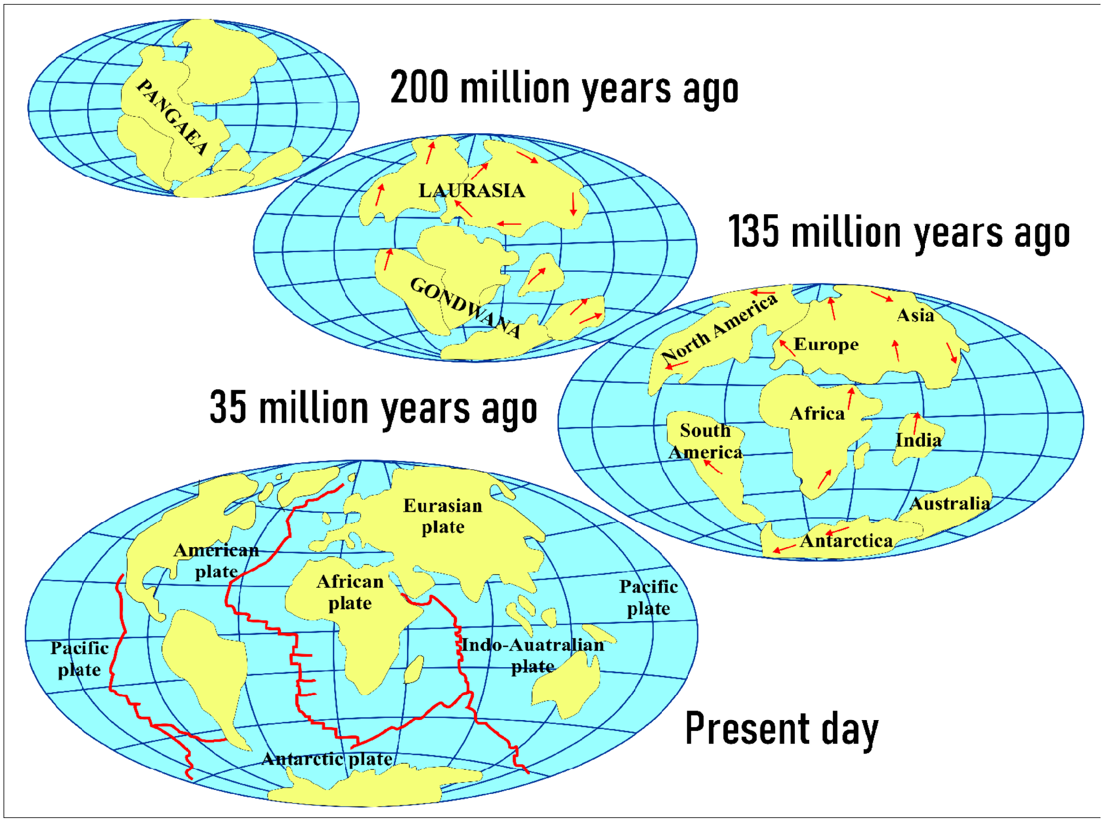


Fig. 2.6: Continental Drift through Time

Evidences of Continental Drift

While proposing his hypothesis, Wegener presented several pieces of evidence of continental unification a long time back which later on drifted away. The evidence was quite convincing and it was widely accepted. They are:

Jig-saw-fit: Both coasts of the Atlantic with South America and Africa are identical and fit very well. This fitting is said to be a jig-saw-fit. It means, as a piece of wood cut in a zigzag way can be jumbled together and that fits as well to form one unit. In the same way, continents broken by endogenic forces are dragged in different directions and could easily be matched.

Geological Matching: There is a very high degree of similarity in terms of the mountain systems of South America and Africa. The mountain system of South Africa is continuing in Argentina of South America. The geological characteristics found in the Appalachian region of North America are found continuing in the British Isles and Scandinavia of Europe.

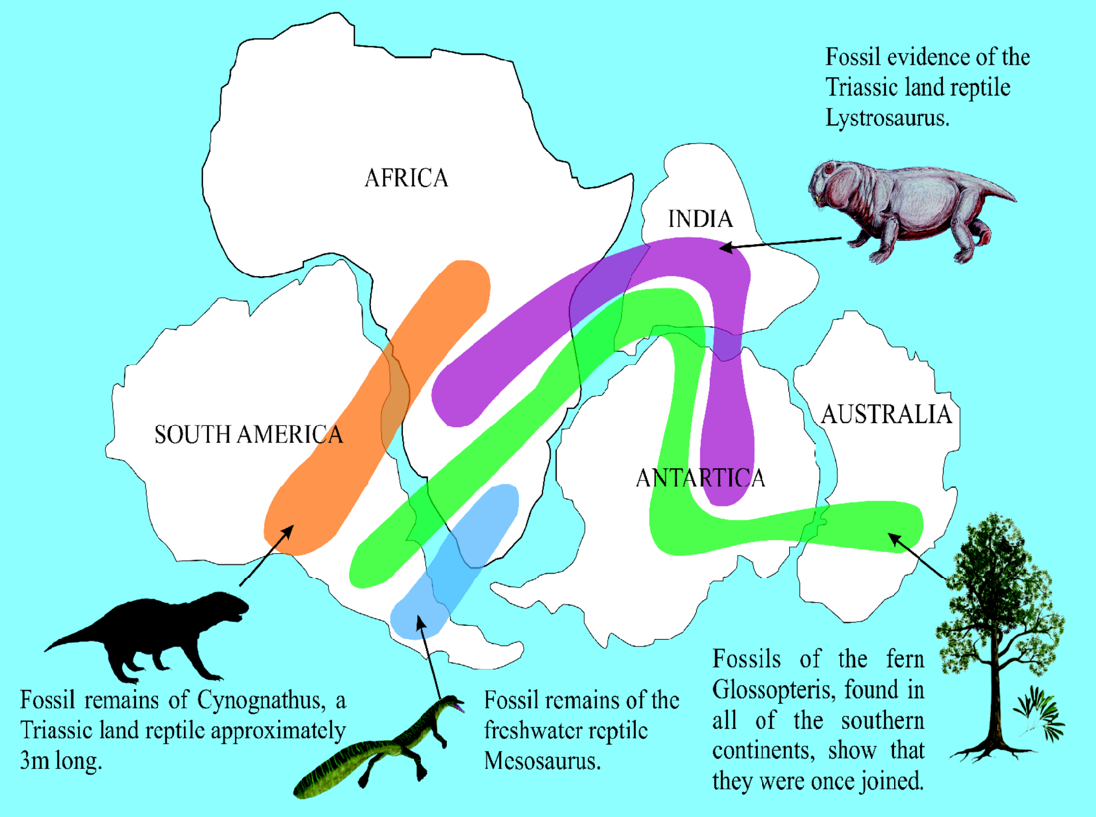


Fig. 2.7: Jig-Saw-Fitting of the Continents

Coal and Vegetation evidence: The distribution of coal and vegetation over South America, Africa, India and Australia proves that they were together in the geological past. The classical glacial deposits during the carboniferous period over these landmasses resemble each other which tell the story of togetherness. Today they lie in different climatic zones.

2.4 PLATE TECTONICS

Continental drift was well accepted for about 50 years from Wegner's proposal in 1912. During this period, numerous scientific studies were conducted like convectional current theory, sea-floor spreading and paleomagnetism. These studies help the scientists to propose the theory of plate tectonics.

According to plate tectonic theory, the earth surface is composed of several plates. Plates are the solid and rigid upper part above the asthenosphere segmented into several blocks. Those blocks are known as lithospheric plates.

A. Major and Minor Plates

There are seven major plates. They are: Eurasian, African, Indo-Australian, Pacific, North American, South American and Antarctic Plates. Apart from above seven major plates, there are about 20 minor plates. A few important among them are: Arabian, Caribbean, Scotia, Nazca, Cocos, Juan De Fuca, Philippine, Caroline, Bismarca, Fiji etc.

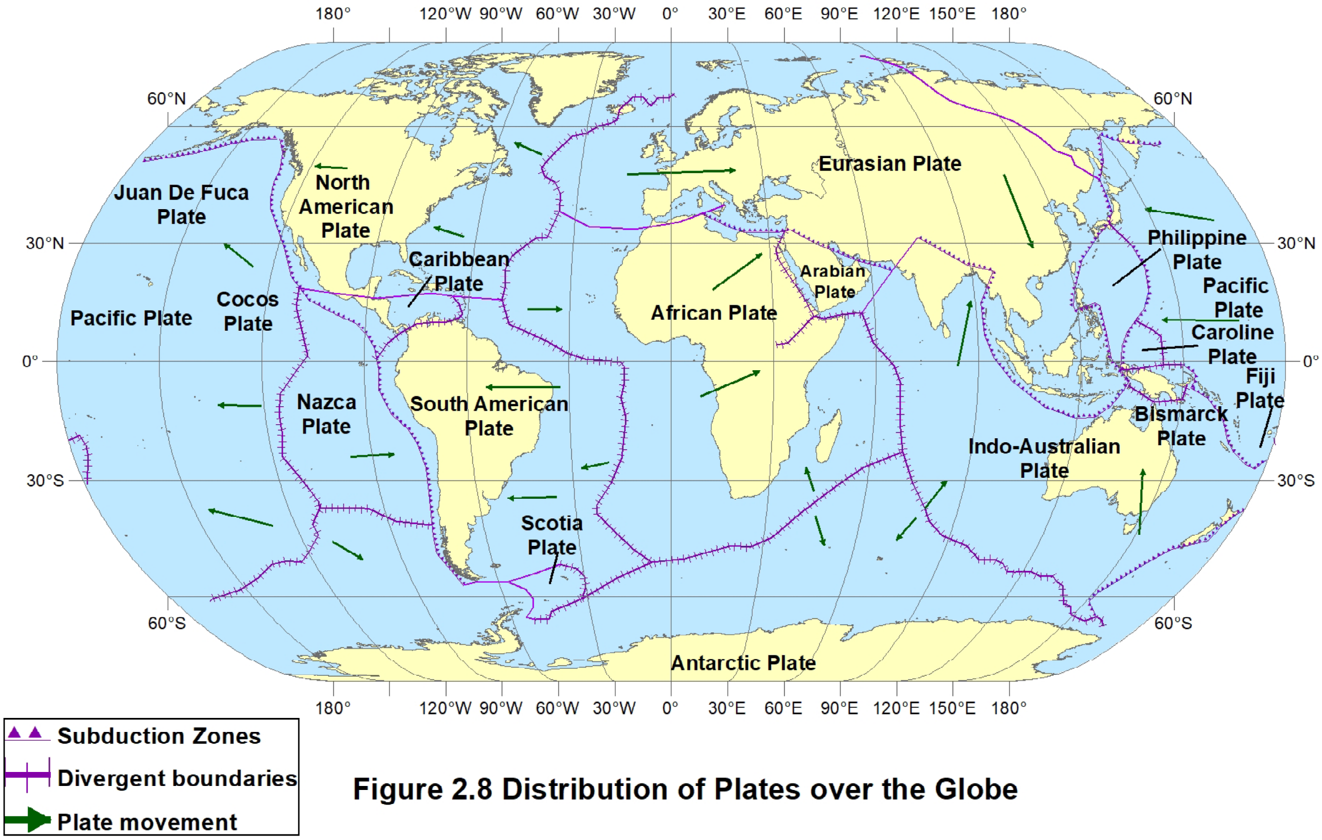


Figure 2.8 Distribution of Plates over the Globe

Fig. 2.8: Distribution of Plates over the Globe

Plates constitute the entire surface of the earth. Plate's thickness is about 100 to 250 km deep from the surface. Below it, the state of the matter is viscous/semi-solid over which plates are moving.

B. Mechanism of Plate Movement and Associated Features

British geologist Arthur Holmes proposed the existence of convection currents underneath the lithosphere. It is getting generated from the asthenosphere by the excessive

Notes

heat available there. The excessive heat is dissipated towards the surface.The convection currents are classified into two rising and falling with divergence and convergence actions respectively.

Divergent Plate Boundary: With rising convection currents, transport of hot and viscous rock material is brought to the surface by splitting it. The molten material penetrates into the split. Hence, a new surface is created and the mammoth sized plate is pushed apart. It happens below the mid-oceanic ridge. It is called a divergent plate boundary. It is also termed as a constructive boundary.

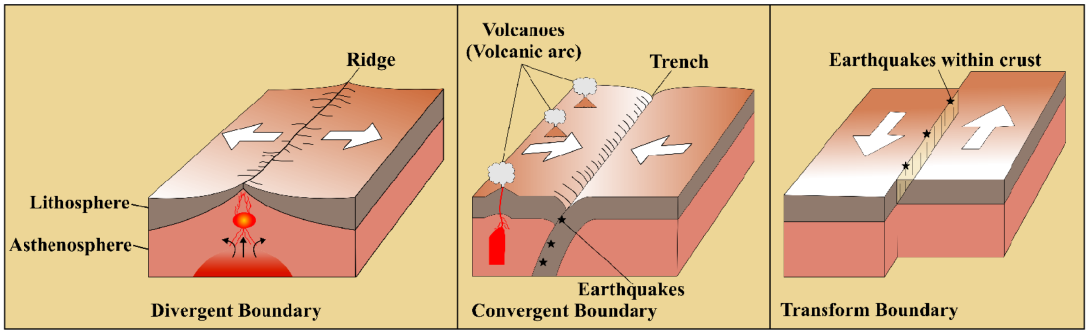


Fig. 2.9: Types of Plate Boundaries

Convergent Plate Boundary: When two sets of convection currents bring two plates together, it is called convergent plate boundary. At this boundary, subduction of plate or formation of mountain is seen. Because of this process, the surface area is reduced or destroyed. Hence, it is termed as a destructive plate boundary.

Transform Plate Boundary: Sometimes plate boundary and plate margin are used as synonymous. But for practical purposes, boundary is a thin line separating the plates whereas margin is an area or zone along the plate boundary. The earth's surface is of two types – land and water. In the same way, the boundary of the plate is also of two types – oceanic and continental.

Due to differential magma ejection along the divergent plate boundary, the differential departure of the plate segment is also observed. This boundary is known as the transform boundary. Along this boundary, neither surface is created or destroyed. Therefore, it is also termed as conservative boundary.

C. Plate Boundaries and Associated Features

Plate boundaries and activities along them are explained above. Due to different actions, different types of features are formed. They are given in Table 2.2:

Notes

Table 2.2: Characteristics of Plate Boundary and Feature Resulted

Activities		**Types of Boundaries**	
	Divergent	**Convergent**	**Transform**
Movement	Plates going apart	Plates coming closer	Lateral sliding
Zone known as Effects	Constructive New surface creation	Destructive Surface loss, lowering of plate into the interior, mountain formation	Conservative Side by side sliding of plates
Features formed	Fault, mid ocean ridge	Trench formation, volcanic islands	No major feature
Volcanism	Yes	Yes	No
Earthquake	Yes	Yes	Yes, but minor

INTEXT QUESTIONS 2.4

1. Who introduce the concept of continental drift.

2. Name any two pieces of continental drift.

   (a)...................... (b) ....

3. Plate boundaries are:

   (a) .... (b) .... and (c) ....

2.5 FOLDS AND FAULTS

Folds are formed when flexible rocks are subjected to compression due to endogenic forces. faults are caused when tough or rigid rocks are broken due to endogenic forces.

A. Folds

Fold is that surface of the earth which is wavy and undulating. Wavy or undulating structure is formed because of compression. Generally, the folding occurs in sedimentary rocks. In folds, there are several layers from surface to inner side. Surface layers are newest in terms of formation while the inners are older by age.

Notes

Folds are upward and downward in appearance. Upward formation is known as anticline while the downward shape is termed as syncline; both the limbs are called hinge zones. When an imaginary line is drawn to separate the fold into two parts, it is called the axial plane. This description is very well understood from Figure.

Types of Folds: Depending on the appearance of the fold and its angle, folds are put into following types:

a. **Symmetrical Fold**: Both sides are similar in terms of length and angle of inclination.

b. **Asymmetrical Fold**: Both sides are dissimilar in terms of length and angle of inclination. One limb is smaller than the other. Smaller side is steeply sloped while the longer side is gently sloped.

c. **Overfold**: When the greater force of compression is operational from one side the fold keeps on turning to the other side and thus inclination is observed. In this fold the turning of the side is more than 90 degrees, and the overturned fold becomes visible.

d. **Recumbent Fold**: When overfold is further intensified, the greater - turned side overlies the other side. In this way, the layer becomes almost horizontal.

e. **Overthrust Fold**: Further intensification of force causes to overthrusting of the overlaying limb. In this case, due to more and more compression, the layer is so stretched that it is about to break but not broken. But when it is broken, it no longer remains a fold, but becomes faulty. It is called nappe which is dealt under fault.

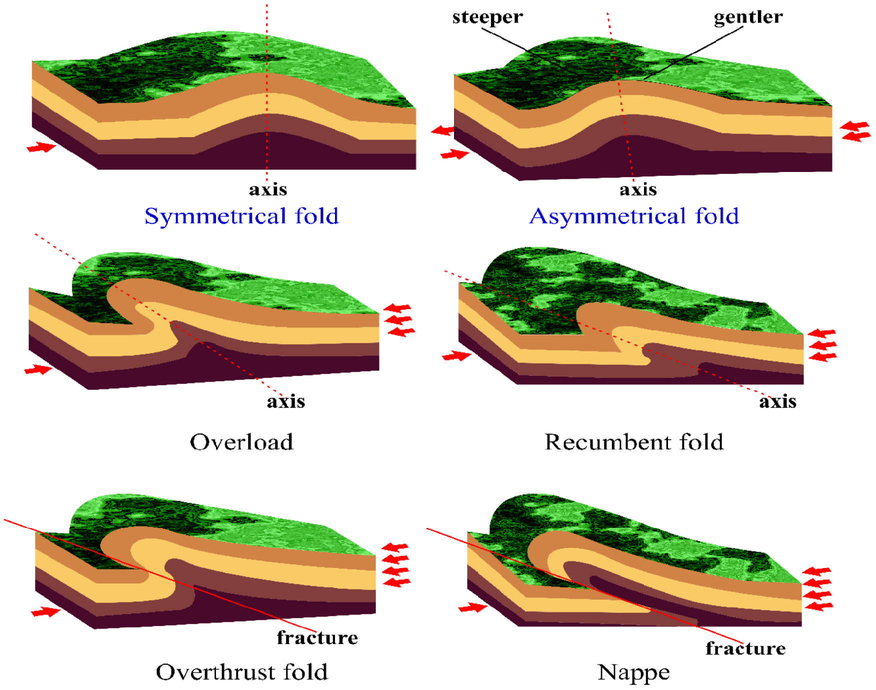


Fig. 2.10: Types of Folds

Notes

Features formed by Folds: Fold Mountains are formed by the process of folding. Most of the mountains found on the globe belong to this category. The surface area is reduced when folds occur because of the inclination of the crust. In terms of plate tectonics, it is called the zone of convergence or the zone of reduction of the horizontal distance of the crust.

B. Faults

Due to internal forces, when the earth's crust bends, a fold is formed, but when it cracks or gets separated, it is called a fault. In this process, minor to significant displacement of crust is resulted. Faults occur due to tension as well as compression both.

Types of Faults

According to the way of formation of the faults, they are grouped under the following types:

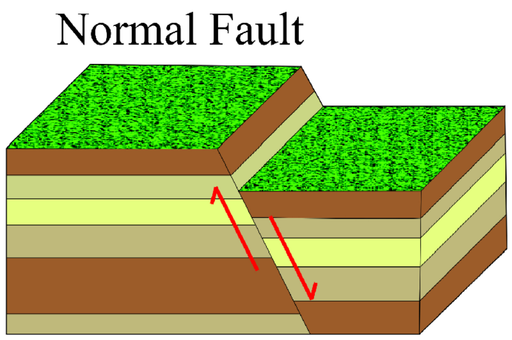
a. **Normal Fault**: Normal fault is formed due to tensional force caused from the interior. In this fault, there is an increase in the surface area.

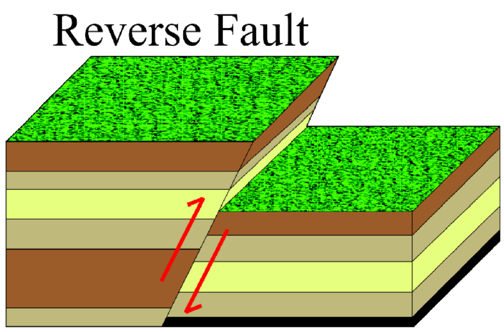
b. **Reverse Fault**: Reverse fault is formed due to compressional force caused from the interior. In this fault, there is shortening in the surface area.

c. **Strike-slip Fault**: In strike-slip fault, the crustal block/mass slips past one another. It is also called a lateral fault.

d. **Oblique Fault**: In oblique fault, the crustal mass is shifted not only away like the normal fault but also gets rotated by sideways movement. For this, just compare the movement in normal fault and oblique fault shown in Figure.

e. **Nappe**: Refer to Figure 2.14. Because of excessive force, when the limb of the fold is broken, it gets detached and thrown away from its original position. This breaking no longer remains a fold but it turns into a fault known as nappe.





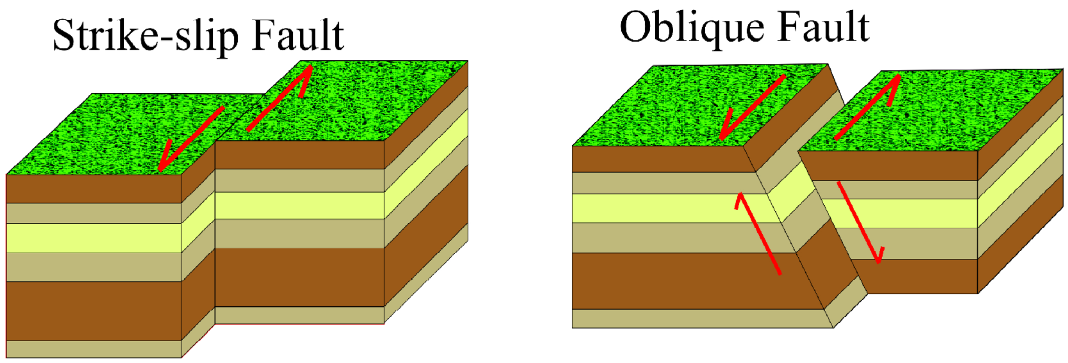


Fig. 2.11: Types of Faults

Features formed by Faults

Two types of features are formed due to faulting. One is depressed called graben or rift valley and the other is elevated called horst. When there is normal faulting, the downthrown side with respect to other forms the graben through which rivers generally occupy. When the widening of the depressed/ downthrown side gets widened, it becomes a rift valley. When there is an upthrown-side with respect to other forms, horst. Horst is also sometimes known as Block Mountain if the height is more.

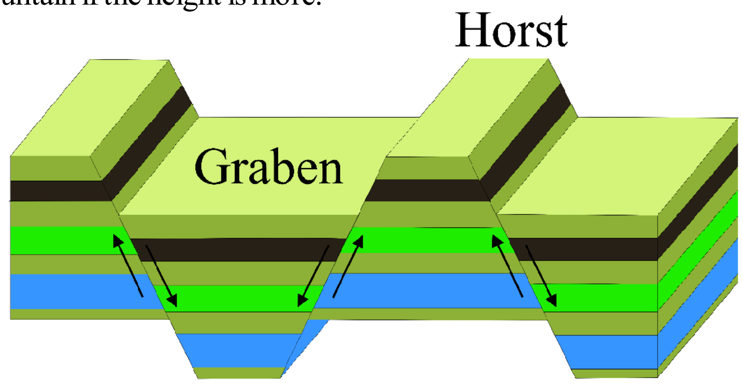


Fig. 2.12: Graben and Horst

INTEXT QUESTIONS 2.5

1. Upward formation of fold is .... and downward is...............

2. Name any three types of fold.

   (a) .... (b) .... and (c) ....

3. Name any three types of fault.

   (a) .... (b) .... and (c) ....

Notes

2.6 VOLCANOES

A volcano is a vent or an opening in the earth's crust through which molten rock material, rock fragments, ash, steam and other hot gases are emitted slowly or forcefully. These materials are thrown out from the hot interior of the earth to its surface. Such vents or openings occur in those parts of the earth's crust where rock strata are relatively weak.

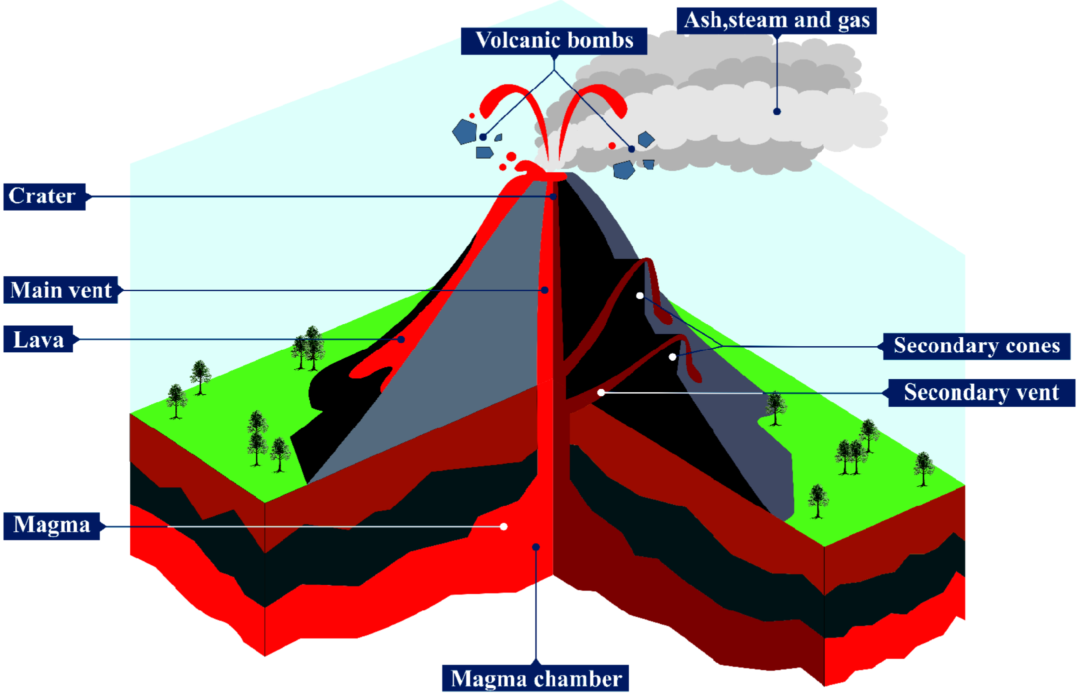


Fig. 2.13: Volcanoes

You may be wondering why such eruptions take place. Hot and molten rock material beneath the solid outer crust is known as magma. When this magma is thrown out to earth's surface, it is known as lava. The tremendous force created by magma and gases break the crust. Magma appearing on the surface is termed as lava. The process by which solid liquid and gaseous materials escape from the earth's interior to the surface of the earth is called volcanism. The volcanic materials gets accumulated around the opening or hole and form a cone. The top of the cone has a funnel shaped depression. It is called its crater.

Types of Volcanoes: Volcanoes are classified on the basis of the nature of volcanism . It includes frequency of eruption, mode of eruption or fluidity and the manner in which volcanic material escapes to the surface of the earth.

A. On the basis of the frequency of eruption, volcanoes are of three types

a. **Active**: This category of volcanoes erupts frequently or has erupted recently.

Important among these include Stromboli in Mediterranean, Krakatoa in Indonesia, Mayon in Philippines, Mauna loa in Hawaii Islands and Barren Island in India.

b. **Dormant**: The volcanoes which have not erupted in recent times are known as dormant volcanoes . They are termed as such the 'sleeping volcanoes'. Important among these are Vesuvius of Italy, Cotopaxi in South America.

c. **Extinct**: Contrary to these two, there are volcanoes which have not erupted in historical times. They are called extinct volcanoes. Mount Popa of Myanmar and Kilimanjaro of Tanzania are important extinct volcanoes.

B. On the basis of mode of eruption

a. **Central Eruption**: When the eruption in a volcano takes place from a vent or a hole, it is called a central type of volcano. Different types of domes or conical hills are formed by this type of eruption depending on the nature of erupted materials. The other characteristics of this mode of eruption are marked by violent explosions due to sudden escape of gases and molten rocks. Visuvious and Fuji-yama belong to this group of volcanoes.

b. **Fissure Eruption**: Sometimes, deep elongated cracks develop due to endogenic forces discussed above in plate tectonics. In this process, magma is expelled through long fissures. Therefore, it is termed as fissure eruption. When lava is spread over a large area, it is called lava plateaus. Deccan Traps of India is one example of fissure type of eruption.

C. On the basis of the fluidity of lava

a. **Volcanoes of acid lava**: Acid lava is rich in silica and has a relatively high melting point. Therefore, it is highly viscous and solidifies quickly. Hence, the acid lava volcanoes cause the formation of usually higher domes with steeper slopes.

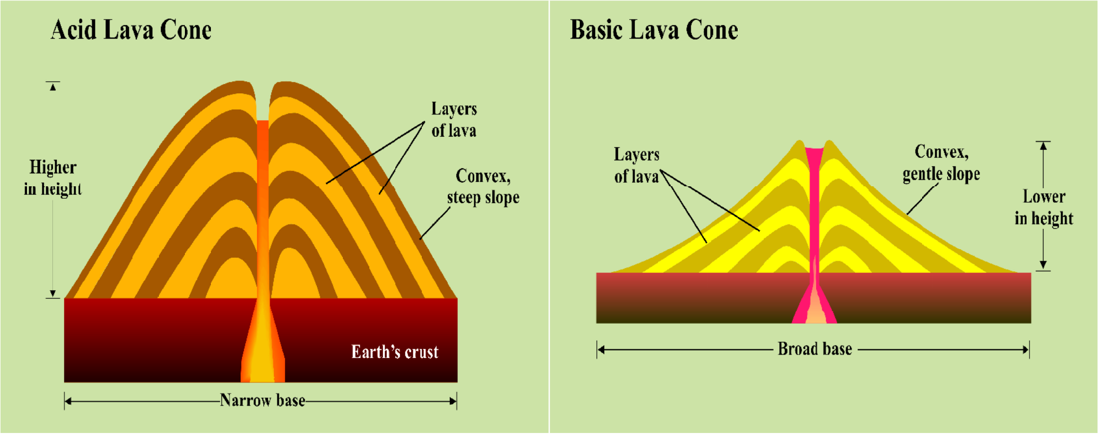


Fig. 2.14: Acidic and Basic Lava Cone

b. **Volcanoes of basic lava**: Since the basic lava is rich in metallic minerals and has a low melting point, it has greater fluidity. In this type of eruption, lava flows far and wide quietly with greater speed and spreads out in thin sheets over a large area. Thus, it leads to the formation of shields and lava domes. The shield volcano of Hawaii Island in the Pacific Ocean is one of these volcanoes.

Distribution of Volcanoes: Most of these volcanoes are found in three well defined belts. First, the Circum-Pacific region has the greatest concentration of volcanoes.That is why; it is called the- 'Pacific Ring of Fire'. This ring extends along the Andes Mountains of South America to Alaska and from the Aleutian Islands to Japan, Philippines, and Indonesia to New Zealand. The Mid-world mountain belt occupies the second position with regard to the numbers of volcanoes. It runs from the Alps in Europe to the western parts of South west Asia. The African rift valley region ranks third.

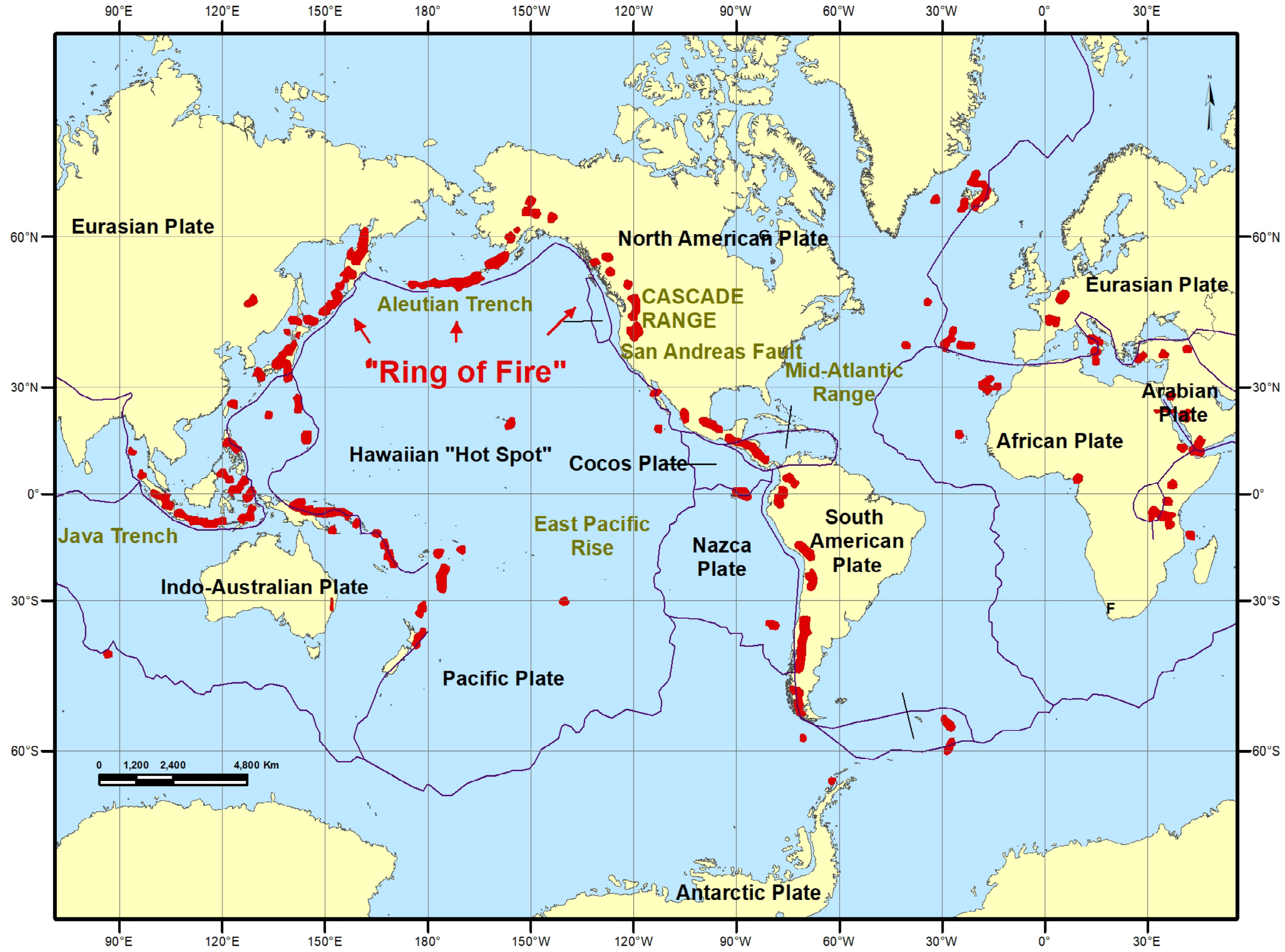


Fig. 2.15: Distribution of Volcanoes and Earthquakes

2.7 EARTHQUAKES

An earthquake is a sudden shaking of the ground surface, ranging from a faint tremor to a wild motion. The frequency of earthquakes varies largely from place to place. The network of seismographic stations all over the world records hundreds of earthquakes every day. But, occurrences of severe earthquakes are limited. The intensity is the highest at or near the epicentre. That is why the maximum destruction occurs at and around the epicentre.

Causes and Effects of Earthquakes : Endogenic forces are the main cause of earthquakes. It results in folding and faulting. Sudden shift or movement in the crust causes the surface to shake. The second important cause is volcanic eruption. The violent volcanic eruption causes vibrations in the earth's crust. The earthquakes are limited to the areas of volcanic activity.

Violent earthquakes are very disastrous. They may themselves cause land-slides, damming of river courses and occurrence of floods. It changes the drainage system of an area as was witnessed in Assam after its 1951 earthquake. The sea waves caused by earthquakes prove most catastrophic in coastal regions. Such tidal waves are called Tsunamis. These waves may wash away coastal cities. Buildings and bridges collapse causing the death of thousands of people. Lines of transport, communication and of electric transmission get disrupted.

Distribution of Earthquakes :The occurrence of earthquakes is a phenomenon in almost every part of the world. But, there are two well-defined belts where they occur more frequently. These belts are the Circum-Pacific belt and the Mid-world mountain belt.The Circum Pacific belt comprises the western coast of North and South America; Aleutian Islands and island groups along the eastern coasts of Asia such as Japan and Philippines. As it encircles the Pacific Ocean, it is named so. The earthquakes in this belt are associated with the convergence boundary of the plates. It is estimated that about 68 percent of earthquakes of the world are occurring in this belt alone.

The second belt extends from the Alps with their extension into the Mediterranean the Caucasus and the Himalayan region and continues to Indonesia. About 21 percent of total earthquakes of the world originate in this belt. Remaining 11 percent occurs in the other parts of the world.

INTEXT QUESTIONS 2.6

1. Krakatoa is a/an ....volcano and Kilimanjaro ss a/an .... volcano.
2. Acidic lava forms .... cone while basic lava
3. Name any two effects of earthquake.

Notes

WHAT YOU HAVE LEARNT

- The interior of the earth is studied based on two types of sources – direct and indirect.
- Study through mining, drilling and volcanic eruptions comes under direct sources while knowing interior by the study of density, pressure and temperature is grouped under indirect sources.
- Seismology is another indirect source which scans the entire earth and tells about it completely.
- Seismic waves are recorded by seismograph in detail and studies by seismologist.
- There are three types of seismic waves - 'P', 'S' and 'L' waves.
- 'P' and 'S' waves are known as body waves as they travel in the interior while 'L' wave are termed as surface waves as they travels in the top layer of the earth surface.
- Based on the chemical characteristics of the rocks found at different depths, earth is divided into three layers SIAL (silicon and aluminium), SIMA (silicon and magnesium) and NIFE (nickel and ferrous).
- Based on the change in the seismic waves velocity in the interior, earth is divided into three layers.
- They are crust – top thin solid later, mantle – top solid, intermediary viscous and again solid denser rocks and core- highly sense rocks with outer liquid and inner solid and abundance of nickel and ferrous.
- The top layer of around 100 to 250 km depth, continents are mobile and it has been proposed by Alfred Wegner with sound evidence.
- Later on it was modified into plate tectonics based on newer researche conducted after the continental drift proposition.
- There are seven major plates such as - Eurasian, African, Indo-Australian, Pacific, North American, South American and Antarctic Plates.
- Apart from them, about 20 minor plates are there with which the surface of the earth is composed of.
- Due to magma coming out along the mid-oceanic ridges, divergence and convergence of plates are eminent.

- At both the boundaries – convergence and divergence, different types of features are formed. Due to divergence and convergence of plates folds and faults are resulted and different types and faults are seen.

TERMINAL QUESTIONS

1. Describe the interior of the earth on the basis of seismic evidence.
2. Explain seismic wave propagation with changing density and state of rocks in interior.
3. Illustrate the characteristics of seismic waves.
4. Examine the chemical composition of the earth's interior.
5. Evaluate the concept of continental drift by giving approprate evidences.
6. What is a plate? Explain its mechanism, and features formed at plate margins.
7. What is fold and how are they formed? Describe the types of fold.
8. What is the fault and how are they formed? Describe the types of fault.
9. Explain the distribution of earthquakes with respect to plate tectonics.

ANSWERS TO INTEXT QUESTIONS

2.1

1. a. Direct

   b. Indirect

2. 10 degree

2.2

1. Seismograph
2. All (crust, Mantle and core), top two (crust and mantle)

2.3

1. a. SIAL b. SIMA and c. NIFE
2. 2900 km

2.4

1. Alfred Wegner
2. Any two

   a. Jig-saw

   b. Geological Matching

   c. Coal and vegetation endemics
3. a. Divergent

   b. Convergent

   c. Transform

2.5

1. Anticline and syncline
2. Any three

   a. Symmetrical

   b. Asymmetrical

   c. Overfold

   d Recumbent

   e. Overthrust.
3. Any three

   a. Normal

   b. Revere

   c. Strike slip

   d. Oblique

   e. Nappe

2.6

1. Active and Extinct
2. Sleep and Flat

Notes

3. Any two

   a. Landslide

   b. Jamming of river course

   c. Occurrence of floods

   d. Damage to life and property

   e. Any relevant effects.

3

EXOGENIC FORCES AND THEIR RESULTANT LANDFORMS

You have learnt in the previous lesson that the vertical irregularities on the earth's surface are the result of interplay between endogenic (internal) and exogenic (external) forces. The significant endogenic processes include diastrophic (slow) and catastrophic (sudden) processes. Endogenic processes are considered as constructional processes as these produce surface irregularities in the form of mountains, plateaus, depressions, faults, folds, etc. on the earth's surface. In contrast to this, exogenic processes are called as gradational or plantation processes because these are continuously engaged in wearing down vertical irregularities created by endogenic processes through denudational mechanisms (including both weathering and erosion) and depositional processes. So, the endogenic and exogenic processes are considered competing forces which are engaged in continual conflict and this continuous interactions between endogenic and exogenic processes produces complex sets of physical landscapes on the surface of the earth. These landforms are not only the physical features of the earth's surface but also the cornerstones of human civilization. The major (second order) landforms found on the earth's surface are mountains, plateaus and plains. In this lesson, we will study the exogenic forces and resultant landforms on the surface of the earth and their socio-economic importance for us.

OUTCOMES

After studying this lesson, learner

- classifes exogenic forces shaping the earth surface;
- describes weathering and gradation and their effects on landforms;
- differentiates between aggradation and degradation processes and agents;
- classifies mountains, plateaus and plains, and
- elaborates the socio-economic significance of major landforms.

Notes

3.1 EXOGENIC FORCES: DEFINITION AND TYPES

The forces which derive their energy from the earth's exterior or originate within the earth's atmosphere are called exogenic forces (also termed as exogenetic forces) or external forces. The action of exogenic forces results in wearing down and hence they are considered as land wearing forces. The processes which occur on the surface of the earth in the influence of exogenic forces are termed as exogenic processes or exogenic geomorphic processes. The energy and material of exogenous processes are held as pools of detention and retention storage at or near the surface of the earth. The two sources of energy which power the various exogenic processes are solar radiation and the potential energy arising from the gravitational attraction of the Earth. In the absence of sufficient resisting forces, gravitational attraction of the Earth causes the downslope movement of water, ice and particles of rock and soil. Solar radiation acts in a different way, providing the energy for the evaporation of water, biological activity, and the functioning of the Earth's atmospheric circulation. Exogenic processes, including the action of water, ice and wind, predominantly involve denudation, that is, the removal of material, and thus generally lead to a reduction in elevation and relief. An exception is the localised deposition of material, to form sand dunes for instance, which causes an increase in relief.

Types of Exogenic Processes

The gradational or plantation work of the earth's surface irregularities is accomplished through (i) Degradation and (ii) Aggradation. Under the Degradation the upstanding landmass is lowered down by weathering (disintegration and decomposition and consequent downslope transfer of weathered materials), mass movement and erosional activities. This mechanism of plantation is termed as level down. In parallel to this, Aggradation is the deposition of the weathered and eroded material and this mechanism of plantation is called level up.

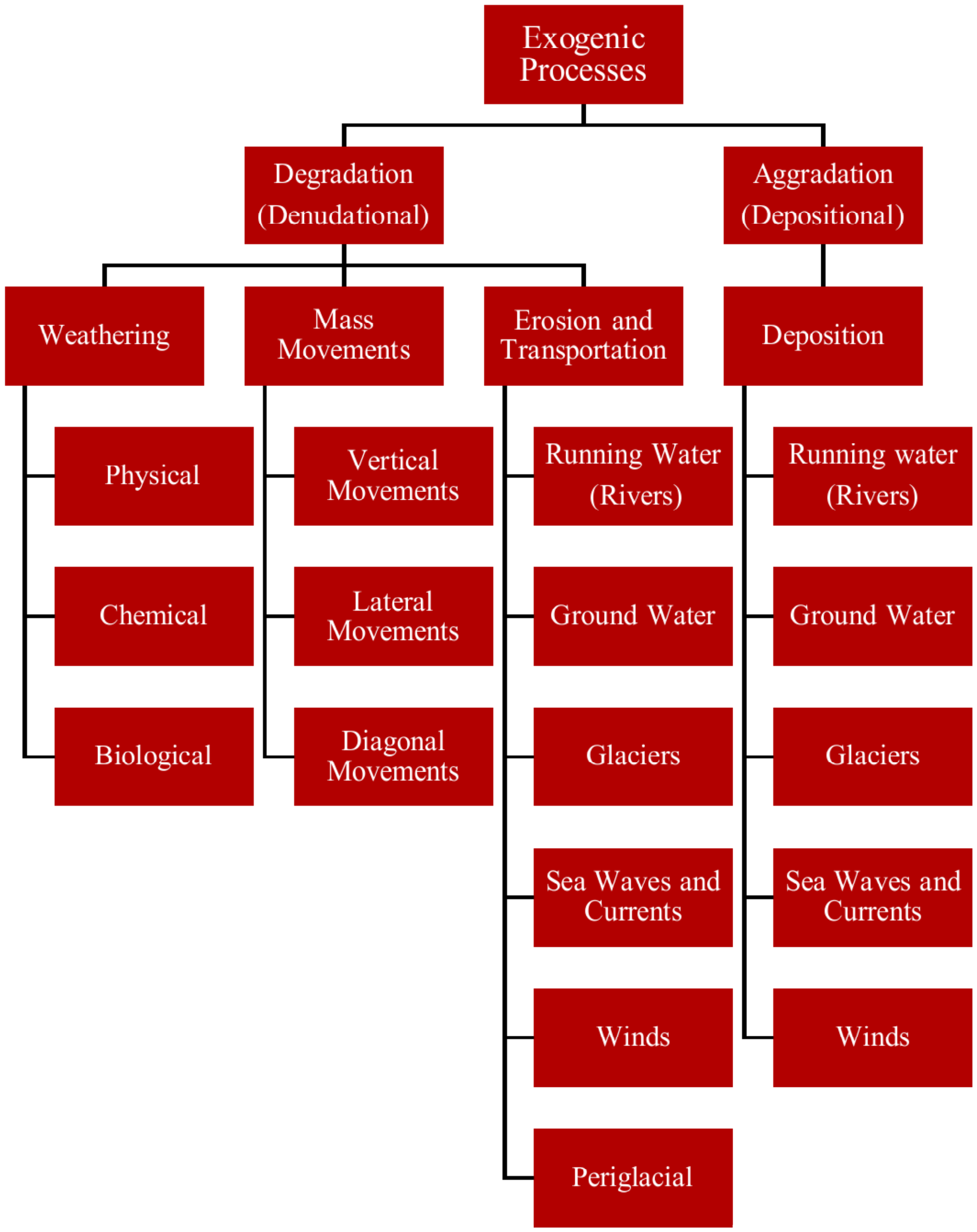


Fig. 3.1 Classification of Exogenic Processes

3.2 MECHANISM OF EXOGENIC PROCESSES

The mechanism of exogenic geomorphic processes is controlled by a number of factors. As there are different physio-climatic regions owing to variations in thermal gradients created by latitudinal, seasonal, and land-use spread on the surface of the earth, the exogenic geomorphic processes vary from region to region. The type, density and distribution of vegetation which

largely depend upon precipitation and temperature also exert influence indirectly on exogenic geomorphic processes. Along with this, there may be local variations due to altitudinal differences, aspect variations and the variation in the amount of insolation received by north and south facing slopes as compared to east and west facing slopes. Further, due to differences in wind velocities and directions, amount and kind of precipitation, its intensity, the relation between precipitation and evaporation, daily range of temperature, freezing and thawing frequency, depth of frost penetration, the geomorphic processes vary within any climatic region. Climatic factors being equal, the intensity of action of exogenic geomorphic processes depends upon the type and structure of rocks. The term structure includes such aspects of rocks as folds, faults, orientation and inclination of beds, presence or absence of joints, bedding planes, hardness or softness of constituent minerals, chemical susceptibility of mineral constituents; the permeability or impermeability. Finally, it boils down to one fact that the differences on the surface of the earth though originally related to the crustal evolution continue to exist in some form or the other due to differences in the type and structure of earth materials, differences in geomorphic processes and in their rates of operation. Some of the exogenic geomorphic processes have been dealt with in detail here.

3.3 WEATHERING AND MASS WASTING

Weathering is the action of elements of weather and climate over earth materials. There are several processes within weathering which act either individually or together to affect the earth materials in order to reduce them to fragmental state. It is an in-situ or on-site process, as very little or no motion of materials takes place in weathering. The process of weathering is conditioned by many complex geological, topographic, climatic, and vegetative factors. Climate played the most vital role. There are three major groups of weathering processes:

i. Physical or Mechanical

ii. Chemical and

iii. Biological weathering processes.

	Weathering		
Processes	Physical or Mechanical	Chemical	Biological
Agents	Water Moisture Frost Insolation Wind	Oxygen Carbon dioxide Hydrogen	Vegetation Animals Micro-organisms
Types	Block Disintegration Granular Disintegration Exfoliation Shattering Spalling Flaking Sheeting	Oxidation Carbonation Solution Hydration Chelation Hydrolosis	Plant weathering Animal weathering Biochemical weathering Anthropogenic weathering
Resulted Landforms	Exfoliation Domes, Block fields, Flutes, Rills, Runnels, Gutters Rock-basins Tafoni Alveoli, etc.		

Fig. 3.2 Weathering: Processes, agents, and types

Generally, the process of weathering is the complex result of all these phenomena. It is very rare that these processes ever operate completely by itself, but dominance of one process can be seen quite often. Physical or mechanical weathering can be considered as the disintegration of rock masses into blocks, boulders, cobbles and pebbles, sands, and silts due to variation in temperature, frost action, wind action and unloading of superincumbent pressure. Chemical weathering is the disintegration and decomposition of rock masses due to chemical responses. Oxidation, solution, hydration, carbonation, chelation, and hydrolysis, etc. are the most recognized chemical reactions which affect the chemical composition of the rock masses. Apart from the mechanical and chemical reactions, biological agents also affect the rock's structure which includes floral (physical and chemical both), faunal (burrowing animals, worms

and other organisms), and anthropogenic (mining, blasting of hills for road and dam construction, quarrying for building and industrial material, deforestation, agriculture and many more).

Fig. 3.3 Weathering products: Landforms.

Mass Movements

Disintegrated and fragmented material due to the mechanism of weathering processes (mechanical, chemical, or biological) is called debris or rock-wastes. Generally, movement of this waste material down the hill slope under the influence of gravity is called mass movement or mass wasting. The sliding or flowing of weathered materials ranging from very fine (soils) to very coarse and large sized rock materials (boulders) is due to their position and to gravitational forces, but mass movement is accelerated by presence of water, ice, and air.

Table 3.1

Classification of Mass movements

Direction of movement	**Vertical**		**Lateral**		**Diagonal**		
Type of movement	Fall	Subsidence	Slide	Spread	Creep	Slide	Flow
Presence of transporting agent	No	No	Minor in basal layer	Moderate in basal layer	Minor	Minor to mod-erate	Major
Type of mass movement	Rock fall, Earth-fall, Topple	Collapse settlement	Block slide	Spread camb-ering	Soil creep, Rock creep, Talus creep	Rock slide, Debris slide, Soil slip, Slump	Solifluction, Mudflow, Rock Glacier, Rock avalanche

Notes

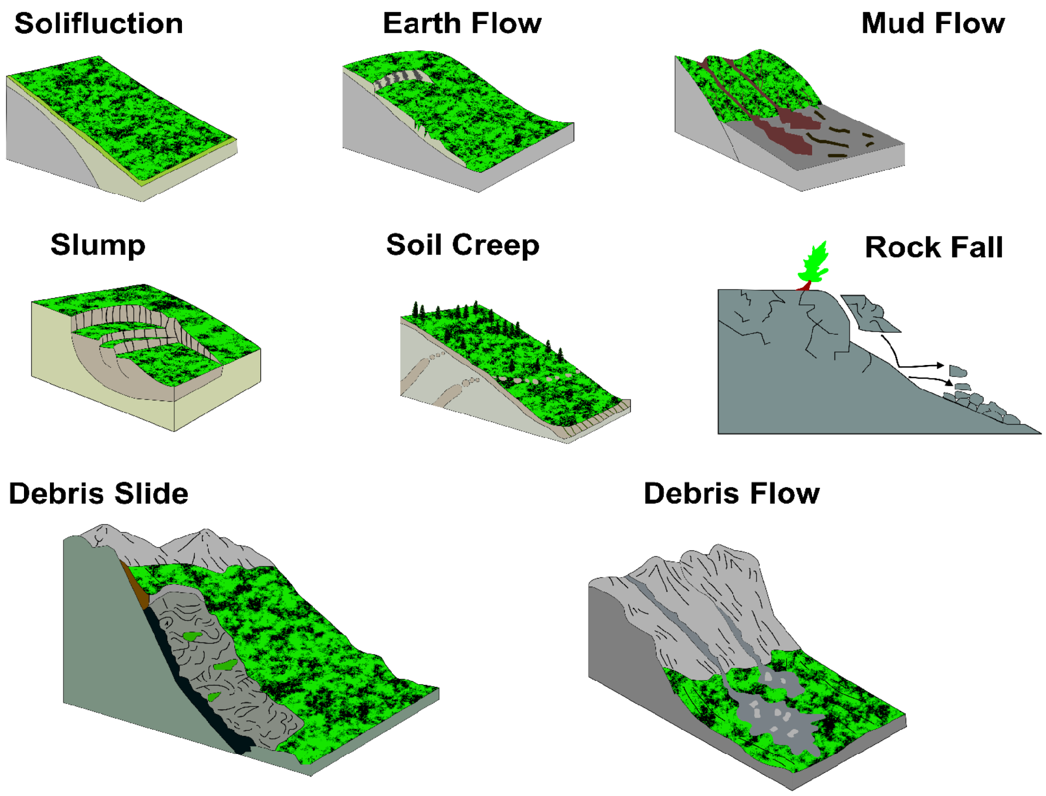


Fig. 3.4 Different types of Mass movements

3.4 EROSION, TRANSPORTATION AND DEPOSITION

Exogenic processes are generally called erosional processes which perform three-phase work i.e. erosion, transportation and deposition. Erosion is the acquisition and transportation of rock debris by geomorphic agents like running water, the wind, waves, glaciers, etc. Though weathering aids erosion, it is not a precondition for erosion to take place. (i.e., erosion can take place in unweathered conditions also). The deposition is a consequence of erosion, as erosional agents lose their velocity and energy on gentle slopes and materials carried by them start to settle themselves.

The erosional work by different processes is performed through the mechanism of:

a. Corrasion or Abrasion

b. Corrosion or solution

c. Attrition

d. Hydraulic action

e. Deflation

f. Periglacial erosional processes (Nivation, Congelifraction, etc.)

Notes

a. Corrasion or Abrasion involves the removal of loosened materials of the rocks by different erosional processes in different manner. Erosion tools refer to all those solid materials (boulders, cobbles, pebbles, sands etc.) with the help of which erosional agents attack and abrade the rocks. The degree of abrasion depends on a host of variables, e.g. nature of erosional agents such as rivers, groundwater, sea-waves, glacier, wind etc., nature of erosion tools, nature of geomaterials, force of erosional processes, gradient etc.

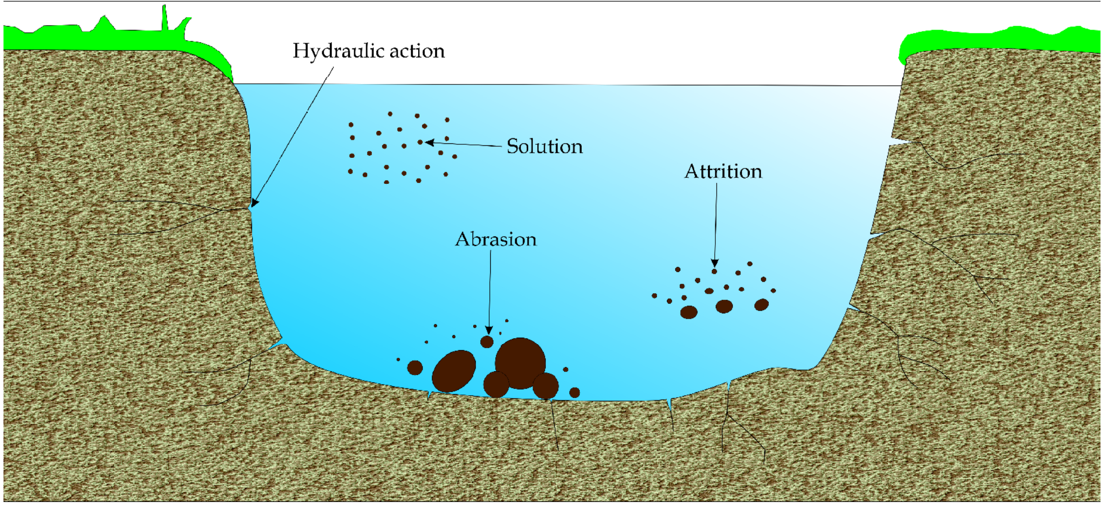


Fig. 3.5 Types of erosional processes

b. The mechanism of corrosion involves dissolution of the soluble materials through the process of disintegration and decomposition of carbonate rocks, which is effectively corroded by running water, groundwater and sea waves.

c. Attrition refers to mechanical tear and wear of erosion tools suffered by themselves. The boulders, cobbles, pebbles etc. while moving downstream with water collide against each other and thus are fragmented into smaller and finer pieces in the transit. Attrition by wind involves mechanical breakdown of rock particles while they are transported by wind through the processes of saltation and surface creep.

d. The breakdown of rocks due to pressure exerted by water currents of the rivers and sea waves is termed as Hydraulic action. It is the mechanical loosening and removal of materials of rocks by water alone without the help of erosion tools. The rivers erode their valley walls through hydraulic action.

e. Deflation is the process of removing, lifting and blowing away dry and loose particles of sands and dust by winds. It happens in semi-arid or arid regions. Congelifraction (frost weathering), Congelifluction (soil creep), nivation (snow patch erosion), etc. are significant weathering and transportation mechanisms performed by periglacial agents.

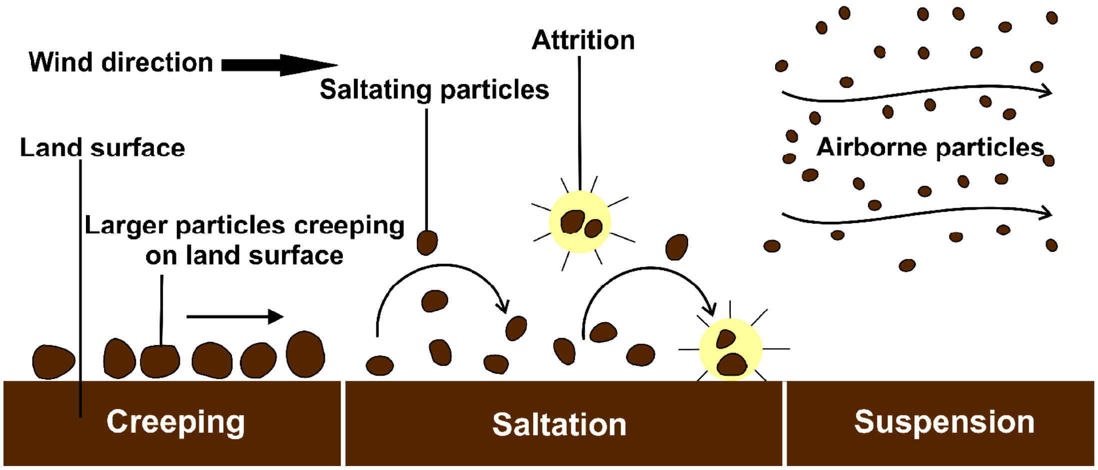


Fig. 3.6 The process of erosion and transportation by wind

The transportation work by different geomorphic processes is accomplished through flotation, suspension, traction, saltation, solution etc. such as running water (rivers) transports sediments through traction, saltation, suspension and solution. The mechanism of saltation is extremely slow, involves the transport of load with water currents wherein coarse load moves downward by leaping and jumping through valley floors. The downstream movement of loose materials on the valley floor is called traction. The bed-load being transported by traction method consists of gravels, pebbles, cobbles and boulders. The materials of medium size are suspended in water due to buoyancy.

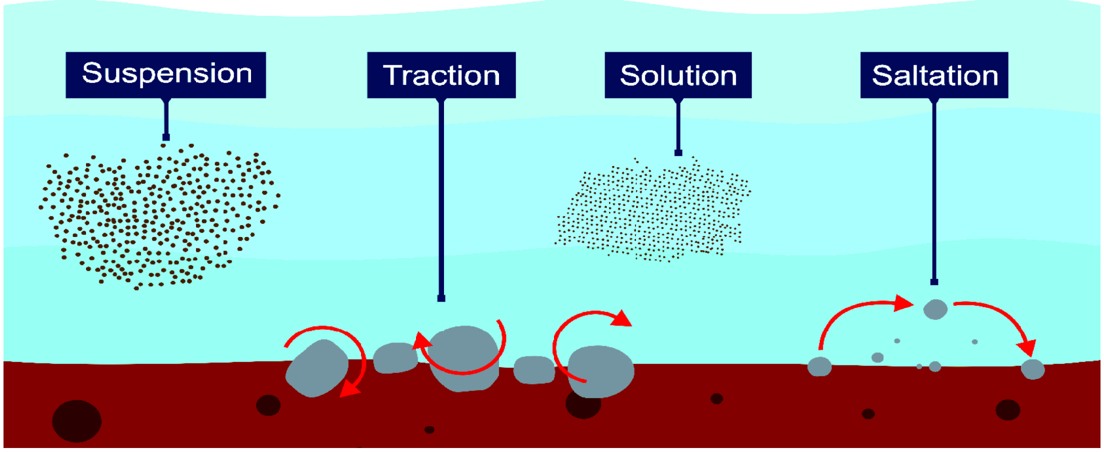


Fig. 3.7 Four ways of transportation in a river

The transportation by streams is unidirectional (downstream). The soluble materials are dissolved in water and become invisible and are transported downstream in solution, which is prominent in groundwater transports. The transportational work of sea waves varies significantly from other agents of erosion and transportation. For example, the backwash (towards sea) currents pick up the eroded materials and transport them seaward but the up rushing breaker waves or surf currents pick up these materials and bring them again to the coasts and beaches. The transportational work of wind differs significantly as wind-transportation

Notes

is multi-directional. Wind transport involves entrainment of loosened grains of sands and dust in the air and their movement to new locations. Only very fine materials are transported to greater distances in one step while coarser materials are transported in stages and steps by rolling, leaping and jumping. Glacial sediments (glacial drifts) are transported along the sides and floors of the glacial valleys and snouts of the glaciers. The debris falling directly into the glacier is transported without touching the bottom of the glacier while the debris falling onto the surface of a glacier is transported down slope with the moving ice mass.

The process of transportation of eroded material is followed by the depositional work which is affected by a variety of factors depending on the agents of erosion and material eroded. For example, the deposition of load carried by the streams is affected by decrease in channel gradient, decrease in stream velocity, obstruction in channel flow, increase in sediments load, etc. Depositional work by groundwater takes place when solvent (water) becomes oversaturated. As the chemical erosion of carbonate rocks continues, the groundwater or say solvent receives more and more solutes and becomes saturated with dissolved sediments and it cannot transport enough sediments. Thus, chemical erosion and sedimentation (deposition) take place together. Deposition by marine processes (sea waves or currents) is most variable and temporary in character because breakers or surf currents abrade the coasts and backwash currents and rip currents bring them seaward and deposit at the lower segments of wave-cut platforms. These sediments are again picked up by surf currents and breakers and are brought to the coasts. Thus, marine sediments are reworked by sea waves again and again.

Depositional work by wind is geomorphologically very important because significant features like sand dunes and loose arcs are formed. Deposition of windblown sediments occurs due to marked reduction in wind speed and obstructions caused by bushes, forests, marshes and swamps, lakes, big rivers, walls etc. The debris carried by glaciers arc collectively called as glacial drifts which include till, ice-contact stratified drift, outwash etc. The unsorted and unstratified glacial drifts are called tills which are further divided into (i) basal till and (ii) ablation till. The glacial deposition is generally called moraine.

INTEXT QUESTIONS 3.1

1. Name the two major sources of energy which empower the various exogenic processes.

   (i) ______________________ (ii) ______________________

2. Classify the degradational or denudational exogenic processes.

   (i) ______________________

   (ii) ______________________

(iii) ____

3. By which process rivers erode their valley walls?

____

4. Name the process of removing, lifting and blowing away dry and loose particles of sands and dusts by winds, in semi-arid or arid regions.

____

5. Name the debris carried by glaciers.

____

3.5 RESULTANT MAJOR LANDFORMS

The mechanism of the endogenic and exogenic operations (erosional and depositional work) is different from one another and hence the landforms produced by each process may be differentiated. Thus, on the basis of dimension and scale, the relief features of the earth's surface may be grouped in three broad categories of descending order. On the smallest scale and covering the largest area is world geomorphology which includes consideration of continents and ocean basins. The consideration and interpretation of worldwide erosion surfaces requires the description and analysis of the characteristics and evolution of continents and ocean basins. Thus, continents and ocean basins become the relief features of the first order. The structural forms developed over a continent or ocean basins as mountains, plateaus, plains, lakes, faults, rift valleys etc. constitute the category of relief features of the second order. These forms owe their genesis mainly to endogenetic forces, particularly diastrophic forces but shaped and developed through exogenic forces. Micro-level landforms developed on these second order relief features by exogenic degradational and aggradational processes originating from the atmosphere dominate in this category, called third order landforms. These landforms may be erosional (e.g. river valley, glacial valley, karst valley, terraces, cirques, canyons, sea cliffs, etc.), depositional (e.g. flood plains, bars, eskers, delta, sea beaches, sand dunes, stalactites, stalagmites, tufa, etc.), residuals (e.g. inselbergs) and sometimes minor tectonic features (by endogenetic forces).

The micro-level landforms will be discussed in the next lesson. In this lesson, the major landforms (second order) of the earth surface, mountains, plateaus, and plains will be explained in detail.

3.6 MOUNTAINS

Mountains are the most awe-inspiring landform on the surface of the earth. A mountain is an elevated portion of the Earth's crust, generally with steep sides that show significant exposed bedrock, which covers around 27% of the total earth's surface. A mountain differs from a plateau in having a limited summit area, and is larger than a hill. A few mountains are isolated summits, but most occur in mountain ranges. There is no universally accepted definition of a mountain. Elevation, volume, relief, steepness, spacing and continuity have been used as criteria for defining a mountain. According to the Oxford English Dictionary, a mountain is defined as "a natural elevation of the earth surface rising more or less abruptly from the surrounding level and attaining an altitude which, relative to the adjacent elevation, is impressive or notable."

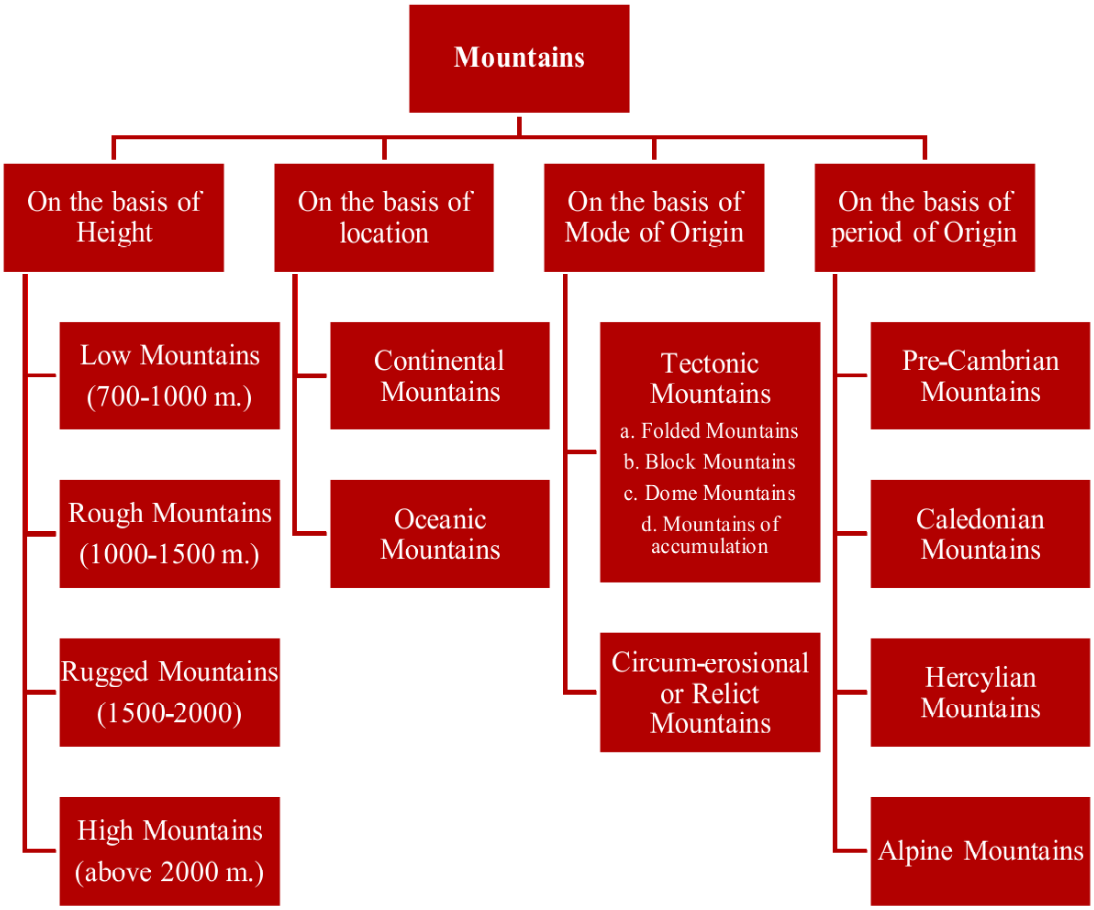


Fig. 3.8 Classification of Mountains

On the basis of their mode of origin, the mountains have been classified as:

a. Folded Mountains

Folded mountains are formed due to folding of crustal rocks by compressive forces generated by endogenetic forces coming from within the earth. These are the highest and most extensive mountains of the world and are found in all the continents. Rockies, Andes, Alps, Himalayas, Atlas etc. are the examples of folded mountains.

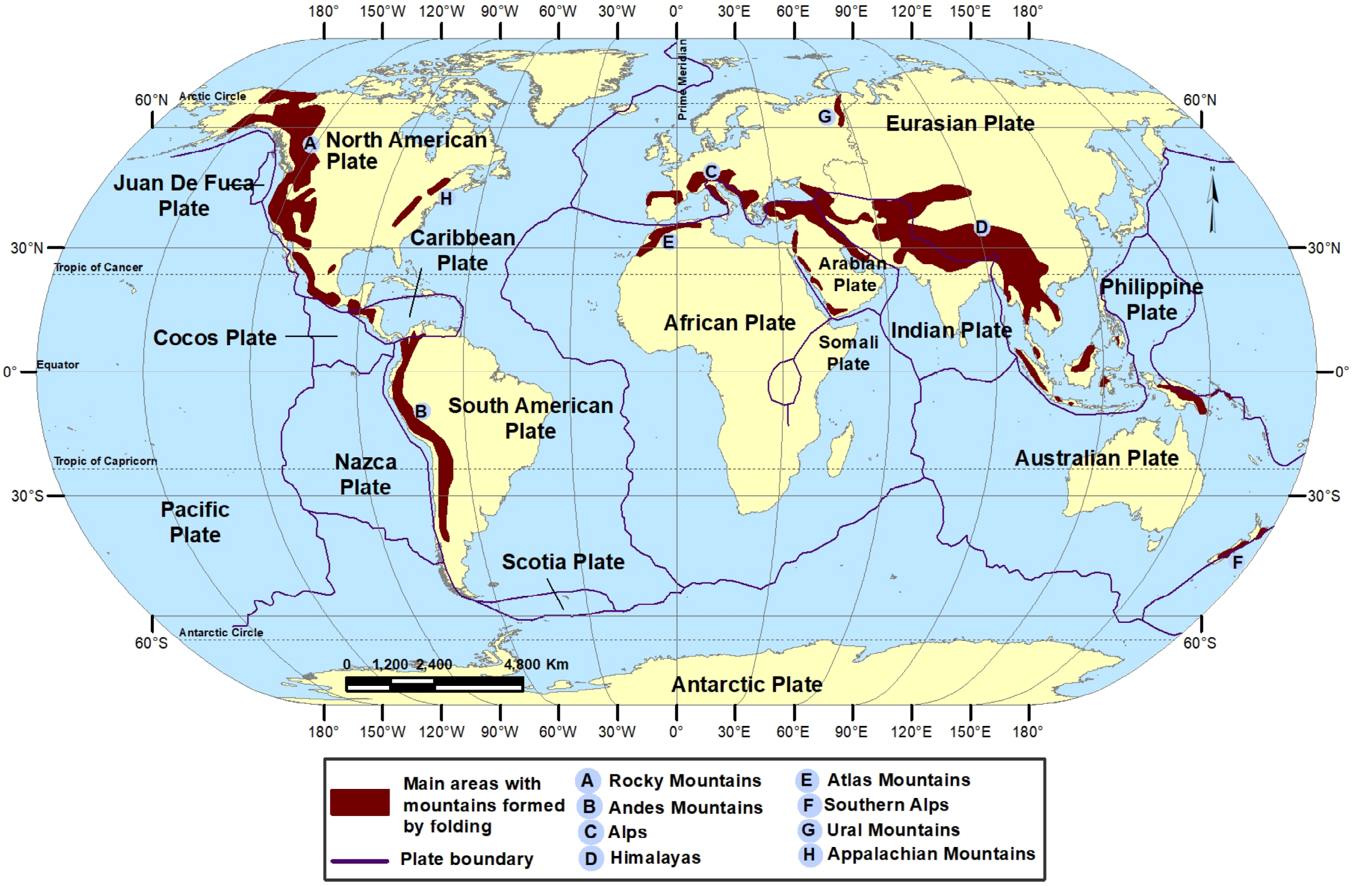


Fig. 3.9 Distribution of Important Fold Mountains of the World

Block Mountains

Block mountains are the result of faulting caused by tensile and compressive forces motored by endogenetic forces coming from within the earth. Block mountains represent the upstanding parts of the ground between two faults or on either side of a rift valley or a graben. Essentially, block mountains are formed due to faulting in the ground surface. They are also called horst mountains. The Vosges in France, Black Forest Mountains in Germany are the typical examples of block mountains.

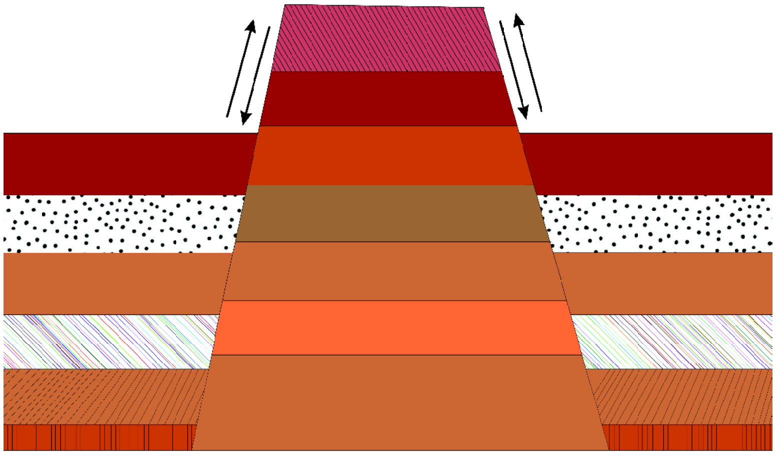


Fig.3.10 (a) Formation & Block Mountains

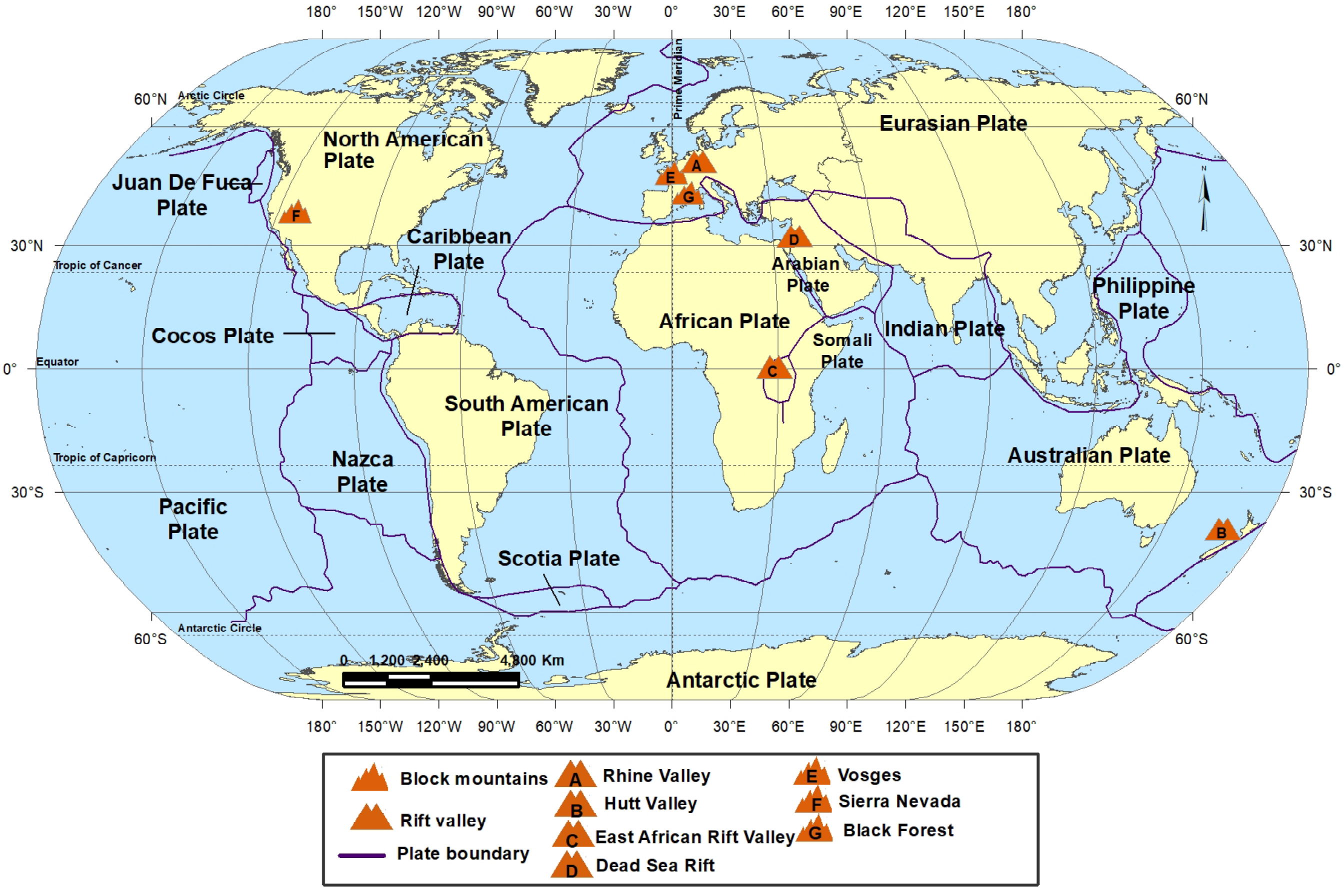


Fig.3.10 (b) Formation of Block Mountains

b. Dome Mountains

These mountains are originated by magmatic intrusions and upwarping of the crustal surface. Examples: normal domes, lava domes, batholithic domes, laccolithic domes, salt domes etc. Typical example of domed mountain is Weald in southeast England.

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c. Mountains of Accumulations

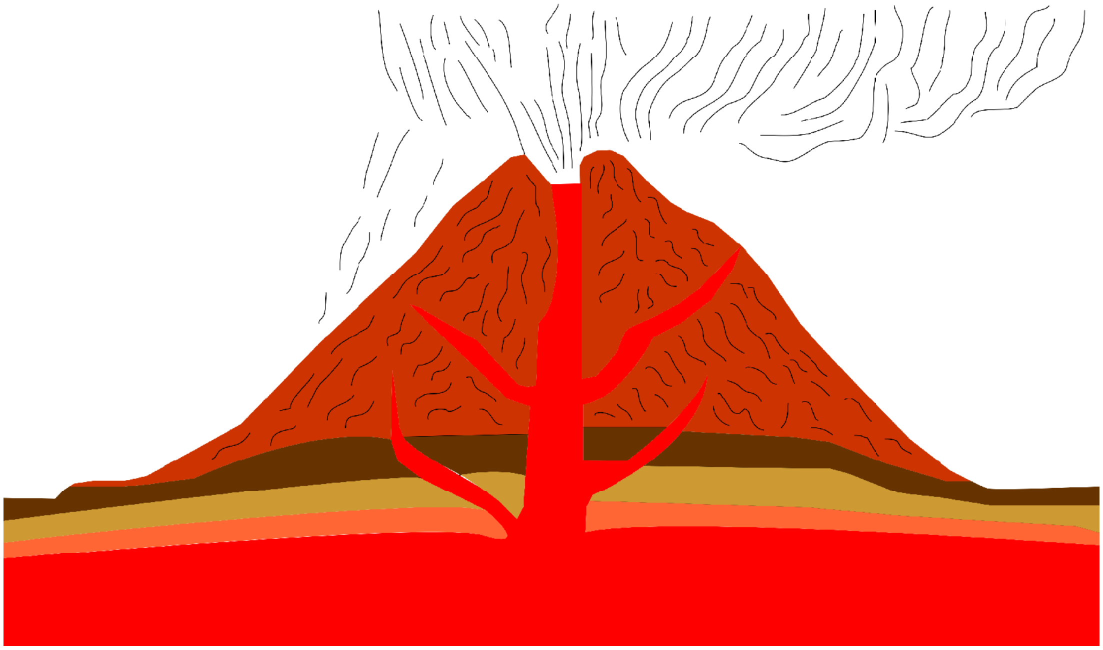

Fig. 3.11 Formation of Volcanic Mountains.

These mountains are formed due to accumulation of volcanic materials. Thus, these are also called volcanicc mountains. Different types of volcanic cones (e.g. cinder cones, composite cones, acid lava cones, basic lava cones etc.) come under this category. Mount Mauna Loa in Hawaii Islands, Mount Popa in Myanmar, Vesuvius in Italy, Cotopaxi in Ecuador and Fuji Yama in Japan are examples of volcanic mountains.

d. Circum-erosional or Relict or Residual Mountains

Fig.3.12 Aravalli Range, India

As soon as an elevated mountain range appears on the earth's surface due to internal forces, the agents of gradation begin their work of levelling it down. To a large extent, the process of wearing down depends on the shape and structure of the rocks. After thousands of years, soft rocks are worn down into sand and the hard rocks are left standing up in the area that has been reduced in height. These are called relict or residual mountains. Hills like the Nilgiris, the Parasnath, the Rajmahals and the Aravallis in India are examples of residual mountains.

The Significance of Mountains:

Mountains are useful to us and nature in the following ways:

a. Storehouse of Resources

Mountains are the storehouse of natural resources. Large resources of minerals are found in mountains. The Appalachian range in the United States is well-known for coal and limestone deposits. We get timber, lac, medicinal herbs and wood for making pulp from the forests of the mountains. Tea and coffee plantations and some fruit orchards have been developed on mountain and hill slopes of Himalayas and western ghats in India.

b. Abundant Sources of Water

Perennial rivers rising in the snow fed or heavily rain fed mountains are the important source of water. They help in promoting irrigation and provide water for many other uses. For example, The Himalayas is the source of many perennial rivers in India and adjoining nations like Ganga, Yamuna, Brahmaputra, Indus, Sutlej, etc.

c. Generation of Hydro-electricity

Hydro-electricity is generated from the waters of perennial rivers in the mountain regions. The mountainous countries like Japan, Italy and Switzerland, which suffer from the shortage of coal have developed hydro-electricity.

d. Formation of Fertile Plains Downstream

The rivers that originate in the high mountain region bring silt along with water to the lower valleys. This helps in the formation of fertile plains. The great alluvial plain of northern India has been formed by the rivers Ganga, Sutlej and the Brahmaputra and their tributaries.

e. Hotspots for Biodiversity

As half of the world's biodiversity hotspots are concentrated in mountains and mountains support approximately one-quarter of terrestrial biological diversity. Mountains are home to rare animals such as gorillas, snow leopards and the majestic tahr as well as strikingly beautiful plants such as orchids and lobelias.

f. Home of numerous Indigenous people

As many mountain areas host ancient indigenous communities that possess and maintain precious knowledge, traditions and languages. Mountain peoples have developed remarkable land use systems and have a wealth of knowledge and strategies accumulated over generations on how to adapt to climate variability. For example, Bakarwals, Bhotias, Tharu, Lepchas and Mishmis of Himalayas.

g. Natural Political Frontiers

The mountain ranges do act as natural political frontiers between countries and protect them from invasions to some extent. The Himalaya has formed a political frontier between India and China.

h. Influence the Climate

Mountainous areas have lower temperatures. They serve as a climatic divide between two adjoining regions. The Himalaya for example forms a barrier to the movement of cold winds from Central Asia towards the Indian subcontinent. They also force the South West Monsoons to ascend and cause rainfall on their southern slopes.

i. Major Tourist Attractions

Mountains are also becoming recreational refuges from crowded cities for the tourists. The pleasant climate and the beautiful scenery of the mountains have led to their development as centres of tourist attraction. The tourist and hotel industries get additional encouragement in such regions. Shimla, Nainital, Mussoorie, Gangtok Srinagar etc are some of the important hill stations of India which attract tourists all over the world.

j. Sacred landforms on the Earth

For more than one billion people, mountains are sacred places. Their soaring summits, the clouds and thunder that swirl about their peaks, the life-giving waters that flow from their heights, these and other characteristics imbue them with an aura of mystery and sanctity. Mount Kailash, Mount Fuji etc are some of the examples which are important for different religion.

3.6 PLATEAUS

Plateau or Plateaus is an extensive area of flat upland usually bounded by steep slopes on all sides but sometimes enclosed by mountains. The essential criteria for plateaus are low relative relief and some altitude. It covers about 18% of the earth's surface. This landform has a large elevated area on its top unlike a mountain and has nearly an even surface out there. Very often rivers or streams cut out deep valleys and gorges in a plateau region which transforms its

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original smooth topography into a dissected plateau. The vertical expansion is normally 600 metres above sea level, but there are also plateaus of Tibet and Bolivia, more than 3600 metres above sea level. On the basis of their geographical location and structure of rocks, the plateaus can be classified as:

a. Intermontane Plateaus

b. Piedmont Plateaus

c. Continental Plateaus

a. Intermontane Plateau

The plateau which are bordering the fold mountain range or are partly or fully enclosed within them are the intermontane plateaus. Vertical movements raise this extensive landform of nearly horizontal rocks to thousands of metres above sea level. The extensive and over 4500 metres high plateau of Tibet is one such example. It is surrounded by folded mountains like Himalaya, Karakoram, Kunlun, Tien Shan on its two sides. The plateau of Colorado is another well-known example, over one km high into which rivers have cut the Grand Canyon and a series of gorges. The plateau of Mexico, Bolivia and Iran are all other examples of this type & platines.

b. Piedmont Plateau

The plateaus that are situated at the foot of the mountains and are bounded on other sides by a plain or an ocean are called piedmont plateau, The plateau of Malwa in India, Patagonia facing the Atlantic Ocean and the Appalachians situated between the Appalachian Mountain and the Atlantic Coastal Plain in U.S.A are their examples. In their case, the areas once high have now been reduced by various agents of erosion. For this reason, these are also called the plateaus of denudation.

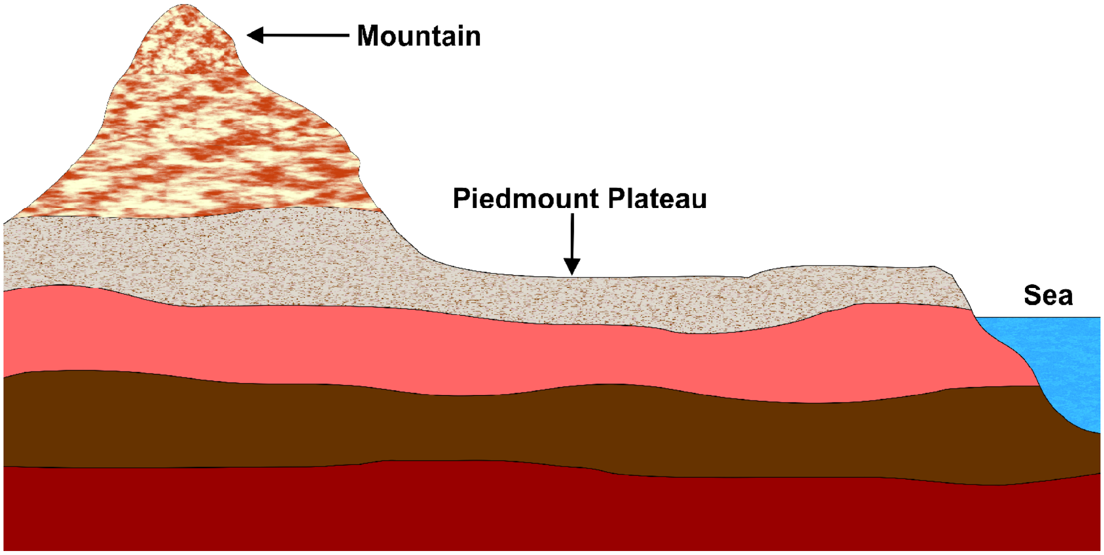

Fig.3.14 Piedmont Plateau

c. Continental Plateau

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These are formed either by an extensive continental uplift or by the spread of horizontal basic lava sheets completely covering the original topography to a great depth. The volcanic lava covered plateau of Maharashtra in India; Snake River Plateau in North West USA are the examples of this type. These are also called the plateau of accumulation. All continental plateaus show an abrupt elevation in contrast to the nearby lowland or the sea. As compared to others, these plateaus cover a vast area like the Great Indian Plateau and those of Arabia, Spain, Greenland, Africa and Australia. They may be tilted on one side without any disturbance in the horizontal nature of underlying rock strata as in the case of the Great Indian plateau.

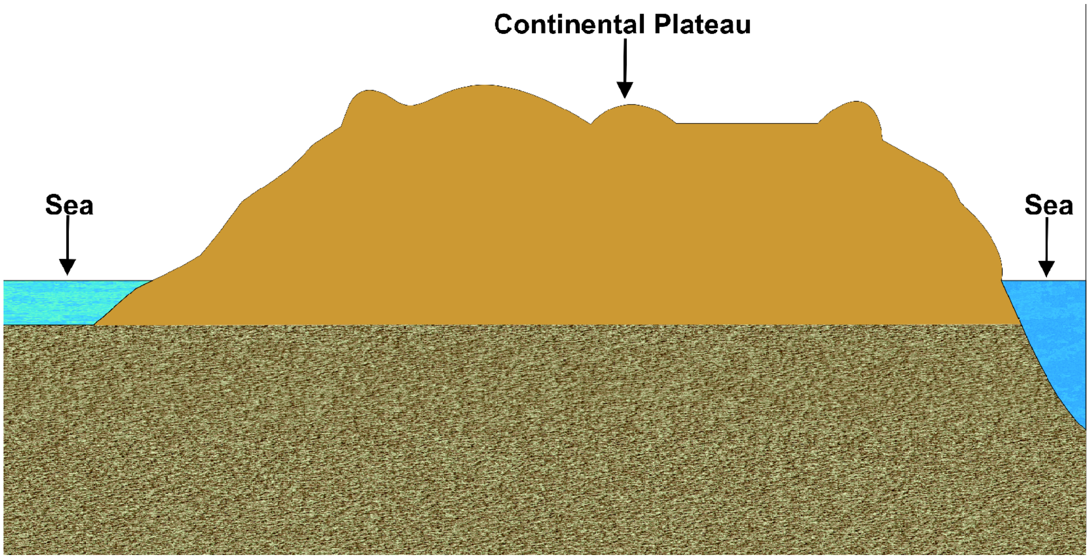


Fig.3.15 Continental Plateau

The Significance of Plateaus

i. Storehouse of Minerals

Most of the minerals in the world are found in the plateaus. Besides, the extraction of minerals is relatively easier on plateaus. These minerals are indispensable as raw material for our industries. We get gold from the Plateau of Western Australia; copper, diamonds and gold from the Plateaus of Africa and coal, iron, manganese and mica from the Chota Nagpur Plateau in India.

ii. Birthplace of various waterfalls

Plateaus are also the source of several waterfalls. These waterfalls provide ideal sites for generating hydel-power. In India, two important waterfalls in the plateau regions are Hundru falls in the Chota Nagpur plateau on the river Subarnarekha and the Jog falls in Karnataka on the river sharavati.

Notes

iii. Cool Climate

The higher parts of the plateaus even in tropical and subtropical regions have cool climates. Hence, they have attracted Europeans to settle there and develop their economy e.g. South and East Africa.

iv. Useful for Agriculture and Animal-rearing

The lava plateaus that are formed due to volcanic eruptions have black fertile soil, which is suitable for cultivation. Plateaus have large grassland areas suitable for animal-rearing specially sheep, goat and cattle. They provide a variety of products such as wool, milk, meat and hide or skin.

v. Tourist attraction

Most plateaus have scenic spot-like features which act as tourist attraction sites. The grand cannons, as well as the numerous waterfalls which are found in most high plateaus, are the perfect examples of tourist attraction features on plateaus. With the attractions, the residents of such areas can earn foreign revenues from the sites.

3.7 PLAINS

Plains are the most important landforms found on the earth's surface. A low-lying relatively flat or slightly rolling land surface with very gentle slope and minimum local relief is called a plain. Plains occupy about more than one-third of the earth's surface. Most of the plains have been formed by the deposition of sediments brought down by rivers. Besides rivers, some plains have also been formed by the action of wind, moving ice and tectonic activity. Plains have an average height of less than 200 metres.

On the basis of their mode of formation, plains can be classified into the following types:

a. Structural plains

b. Erosional plains

c. Depositional plains.

a. Structural Plains

These plains are mainly formed by the uplift of a part of the sea-floor or continental shelf. These are located on the borders of almost all the major continents. The south eastern plain of the United States formed by the uplift of a part of the Gulf of Mexico is an example of this type of plain. The structural plains may also be formed by the subsidence of areas. One such plain is the central low-lands of Australia.

b. Erosional Plains

These plains are formed by the continuous and a long-time erosion of all sorts of upland. The surface of such plains is hardly smooth. These are therefore also called peneplains which means almost a plain. The Canadian shield and the West Siberian plain are examples of erosional plains.

c. Depositional Plain

Fragments of soil, regolith, and bedrock that are removed from the parent rock mass are transported and deposited elsewhere to make an entirely different set of surface features–the depositional landforms. The type of depositional plains depends on the geomorphic agents of deposition. Plains formed by river deposits are called riverine or alluvial plains. The Indo-Gangetic plain of the Indian subcontinent, the Hwang-Ho Plain of North China and the Ganga-Brahmaputra Delta Plain in Bangladesh are examples of alluvial plains. Deposition of sediments in a lake gives rise to a lacustrine plain or a lake plain. The Valley of Kashmir and that of Manipur are examples of two most prominent lacustrine plains in India. When plains are formed by glacial deposits, they are called glacial or drift plains. Plains of Canada and North-Western Europe are examples of glacial plains. In the semi-arid and arid regions Loess plains are the results when wind is the major agent of deposition. Loess plains of North- Western China are formed by the deposits of loose air-borne fine dust particles.

The Significance of Plains

The plains have influenced the human life in the following ways:

a. Most Fertile Soil

The plains generally have deep and fertile soil. Since the plains have a flat surface, the means of irrigation are easily developed. Both these factors have made the plains agriculturally so important that they are often called 'food baskets of the world'.

b. Improved transport and communication system

Being a level or flat land, plains are ideal for constructing roads and railways. Waterways (rivers) can also be used as a mode of transport, thereby leading to a developed system of transport and communication.

c. Favourable climate

Compared to mountains and plateaus, the climate is quite pleasant in the plains. Temperature is not extreme here and rainfall is also suffecient at many plain.

d. Development of industries

Flat land, pleasant climate, developed transport and communication system, availability of labour (the plains being a densely populated area), availability of raw materials, etc., have all contributed to the development of industries in the plains.

e. Centres of Civilizations

The flat land, fertile soil, developed transport and communication system, conducive climate, opportunities of employment, etc., have all led to the growth of settlements followed by civilizations. The major river valley civilizations of the world have flourished in the plains only. Hence, they are aptly referred to as the cradles of civilization. For example, there are the civilizations of the Indus and the Nile Valley.

INTEXT QUESTIONS 3.2

1. Name the three major landforms of second order found on the earth's surface.

   (i) (ii) (iii)

2. Block mountains are the results of which processes?

3. Write the type of the following mountains:

   (a) The Black Forest

   (b) The Himalayas

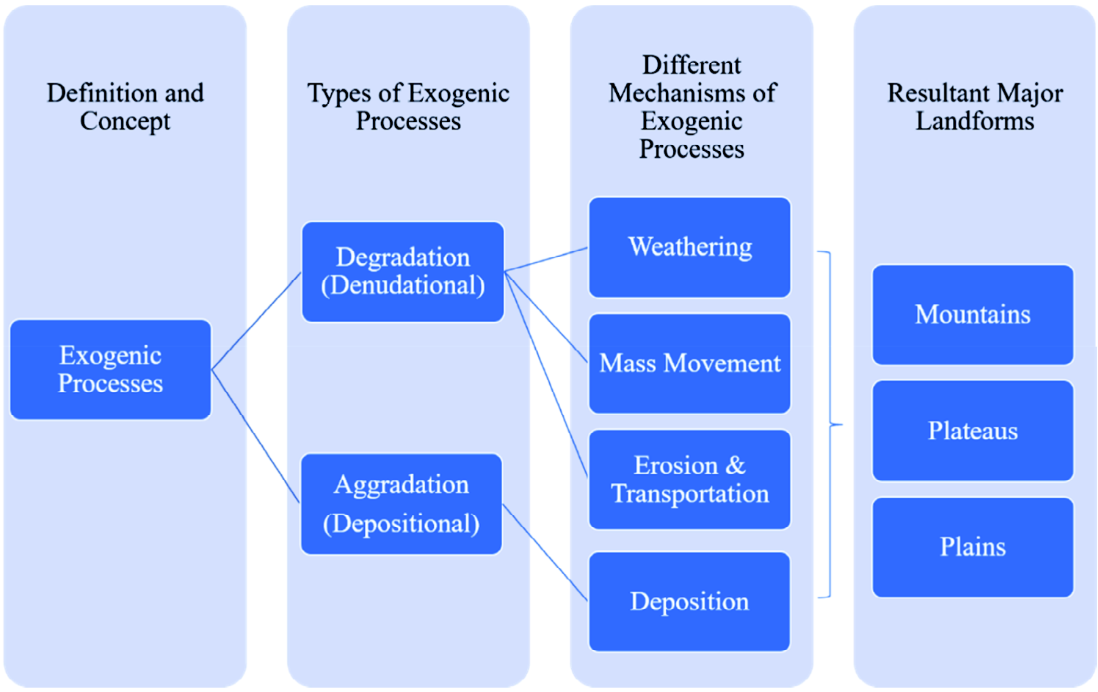
   (c) The Aravalli

   (d) The Fuji Yama

4. Which mountains have surrounded the plateau of Tibet, an intermontane plateau?

5. The Indo Gangetic plain of the Indian sub-continent and the Hwang-Ho Plain of North China are examples of which type of plain?

WHAT YOU HAVE LEARNT



TERMINAL QUESTIONS

1. Define the exogenic processes?

2. Describe the mechanism of erosion, transportation and deposition by various geomorphic agents?

3. Why are plains significant for human beings ?

4. Why are the Mountains called 'Sacred landforms on the Earth'?

5. Distinguish between the following:

   (i) Degradational and Aggradational processes.

   (ii) Intermontane and Continental plateaus.

   (iii) Corrasion and Corrosion.

6. Locate and label the following on the outline map of the world.

   (a) Rockies and Andes Mountains

   (b) Tibetan Plateau

(c) Himalayas

(d) Indo-Gangetic plain

(e) Mount Fuji Yama

ANSWERS TO INTEXT QUESTIONS

3.1

1. (i) Solar radiation

   (ii) Potential energy arising from the gravitational attraction of the Earth.

2. (i) Weathering

   (ii) Mass Movements

   (iii) Erosion and Transportation.

3. Hydraulic action.

4. Deflation.

5. Glacial drifts.

3.2

1. (i) Mountains

   (ii) Plateau

   (iii) Plains

2. Block mountains are the result of faulting caused by tensile and compressive forces motored by endogenetic forces.

3. (a) Block Mountain

   (b) Folded Mountain

   (c) Relict or Residual Mountain

   (d) Volcanic Mountain

4. Himalaya, Karakoram, Kunlun, Tien Shan.

5. Depositional Plains.

4

RUNNING WATER, MOVING ICE, WIND AND SEA WAVES

In the previous lesson, we have discussed many geological processes which are active on the surface and contribute to shaping the earth. These exogenous (external- over earth's surface) and endogenous processes result in ultimate gradation and reducing the uneven earth into level surface. The land features very rarely remain in their original form, shape, size, texture and to some extent its colour also continiouslly changes. These agents of gradation have a major role in erosion, transportation and deposition of weathered rocks. These forces play a vital role in modifying the land features.

The gravity and gradients (slope of an area) plays an important role in shaping various landforms through agents of gradation. The most important geological agents capable of eroding, transporting and depositing the mass from one place to the other are: Running Water (Fluvial landforms by rivers and streams); Glaciers (Glacial landforms by glaciers); Wind (Aeolian landforms by wind) and Sea Waves (Marine landforms by waves). In this lesson we will learn about various erosional and depositional landforms formed by various different of gradation.

OUTCOMES

After studying this lesson, learner:

- describes the importance of various erosional and depositional features produced by action of running water;
- explains the important erosional and depositional features produced by glaciers;
- explains the erosional and depositional features formed by the wind;
- explains the various erosional and depositional features formed by sea waves and
- evaluates significance of running water, moving ice, wind and sea waves for humans.

Notes

4.1 FUNCTIONS OF RUNNING WATER: EROSION, TRANSPORTATION AND DEPOSITION

Rivers play a significant role in shaping the landscape. Rivers transport water by gravity from source of origin to ocean on its journey. The river passes through three courses- upper, middle and lower course during this journey and creates many erosional and depositional features.

Courses of River

The path or route in which a river flows from its point of origin known as 'mouth of river' to its destination i.e. sea or ocean is called the course. The river course can be broadly divided into three sections:

i. The upper course or the stage of youth or the youthful stage or mountain course.

ii. The middle course or the stage of maturity or mature stage

iii. The lower course or the stage of old age or old stage

Table 4.1

Courses of river valley

Features	**Upper Course**	**Middle Course**	**Lower Course**
Source	Glacier or underground (karst)		
Slope gradient	Very steep	Open gently sloping valley	Almost flat or shallow gradient. Gentle slope with floodplains with flat and wide
Discharge of water	Less amount as single stream initially	Large amount as many tributaries join the main river	Very large
Depth of river bed/bed load	Shallow / heavy bedload	Deeper / more suspended sediment	Deep
Velocity	Very high velocity water gushes down from steep valleys	Moderate	Low and slow movement of water

Channel and valley shape	Narrow channels with steep valley	Flat and moderate steep sides. Wider and deeper channels	Flat floor with gently sloping sides. Very wide and deep channels.
Major landforms created	Rapids, waterfalls, canyons, gorges, 'V' shaped valleys	Meanders, oxbow lakes, floodplains, levees, river cliffs, slip off slopes	Deltas, distributaries

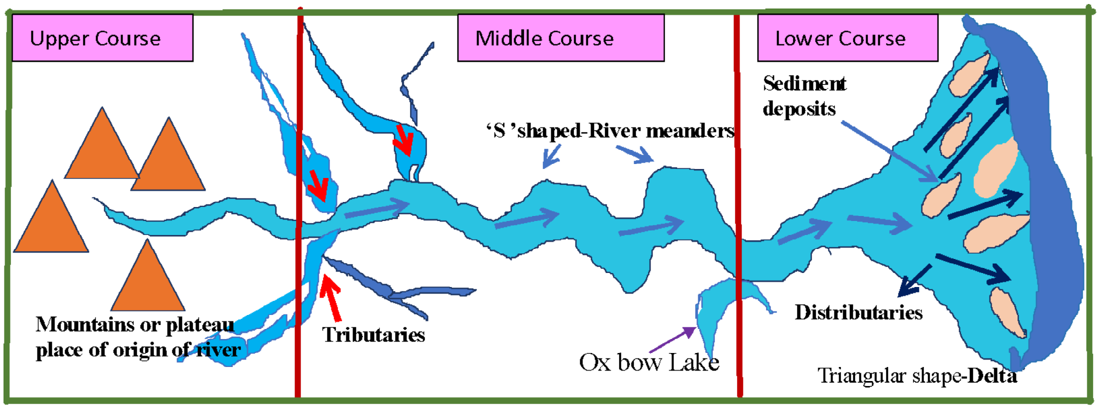


Fig. 4.1 Courses of River Valley

4.2 RUNNING WATER: LAND FROMS

a. EROSION

The cutting and removal of rock debris by the river is called river erosion.

Erosional Landforms

Many erosional landforms are made by running water. They are -

i. **'V' shaped valleys-** The valleys are created by erosional action of rivers in the upper course. At this stage vertical erosion is more dominant compared to lateral erosion. The fast-flowing rivers with steep gradients create this valley. As the river flows downhill at high speeds it removes maximum sediments from the bottom as compared to the sides of the river channel. This process is called down cutting. Weathering helps in widening a valley at the top giving it a typical 'V' shaped cross section. The valley has very steep walled sides along with a narrow floor.

Fig. 4.2 'V' shaped valley by river Zanskar in Ladakh, India

Notes

ii. **Gorge and Canyons-** Hard and resistant bedrock hinder the widening of the valley at the top but down cutting process continues with the vigour of the river which can lead to formation of gorge. A river valley with almost vertical walls is called a gorge. For i.e. Indus gorge, Pakistan Kali Gandaki Gorge, Nepal and the gorge of Gandikota formed by Pennar river in the state of Andhra Pradesh whereas a canyon is very deep gorge with vertical walls and steep sides can stretching for hundreds of kilometres i.e. Grand Canyon created by river Colorado in the USA Fish River Canyon, Namibia and Laitlum canyon, Meghalaya.

Deep gorges also develop in limestone regions in plateau regions and in rocks lying in dry climates. The narrow and very deep gorge or the canyon with vertical walls is also known as 'I' shaped valleys.

iii. **Waterfalls and rapids-** A waterfall is a steep descent made by a river over rocky slopes or ledges . The rivers fall with great velocity and lateral erosion predominates and plunge pools are formed at the base of waterfalls. The streams flow from soft rock to hard rocks. Both lateral and vertical erosion takes place. In most cases the soft rocks (like limestone or sandstone) get eroded and the water falls from a hard ledge of granite or other hard rocks. Waterfalls are also called cascades. For eg. Niagara Falls at the USA and Canada border. Jog falls, India. Victoria falls, Zambia etc. Rapids formed in areas of shallow fast-flowing water in younger streams. There are many tiny waterfalls created within the stream. Adventure sports like water rafting are very common in zones where there are rapids in river channels. For e.g. white water rafting in Rishikesh, India.

Fig. 4.3 Waterfall

Notes

b. TRANSPORTATION

River carries rock particles from one place to another. This activity is known as transportation of load by a river. The load is transported in four ways- (a) Traction (b) Saltation (c) Suspension (d) Solution actions as discussed in previous lesson. It helps in transporting various types of sediments and debris load from one place to other by running water.

c. DEPOSITION

When the stream comes down from hills to a plain area, the surface slope becomes gentle. The decrease in energy hampers transportation; as a result, part of its load starts settling on its own. This activity is known as deposition. Deposition takes place either due to decrease in slope or due to fall in the volume or velocity of river water. Deposition takes place usually in plains and low lying areas. When the river joins a lake or sea, the whole of its load is deposited.

Depositional landforms

(i) **Alluvial fans-** When rivers flow down the steep mountain slopes into the valleys they drop their load of coarse - sand and gravels as their sudden decrease in velocity. The load deposited generally acquires a fan-like shape; therefore they are called alluvial fans.

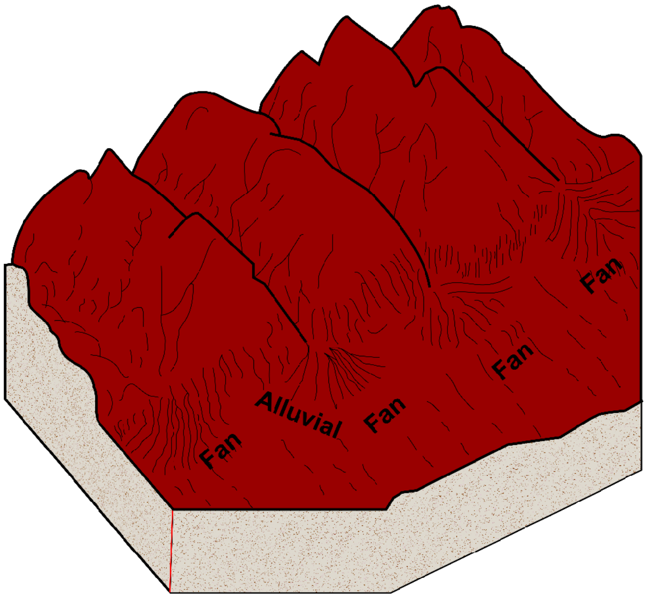


Fig. 4.4 Alluvial Fans

ii. **Meanders-** The term is derived from River Meanders in Turkey which makes winding paths while flowing downstream. When the river is flowing in a relatively plain area even small obstructions on the way forces the river to swing in loops to go around the obstacles. These "S" shaped loops are called meanders.

Notes

iii. **Floodplains and Levees-** Vertical erosion has almost ceased in the lower course and in this stage the river is carrying heavy loads of debris and many tributaries join the main river. In this course the river is rich with large volumes of water and sediments that are brought down from upper and middle courses. The work of the river is totally depositional and it is building up its bed and floodplains. Annual flooding causes spreading of large quantities of sediments over the low- lying areas adjacent to the banks of the river channel building a fertile floodplain.

A raised ridge of coarse material is formed along the river banks of the river. Such ridges are called levees.

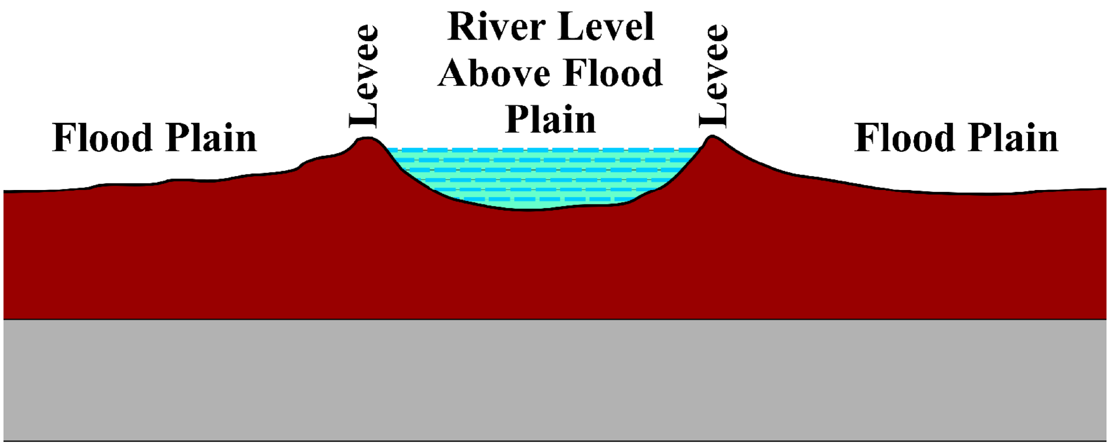


Fig. 4.5 Floodplain and Levees

iv. **Braided streams-** Large sheets of material both fine and coarse are deposited on the level bed and the river splits into a maze of channels. Such stream is called a braided stream.

v. **Ox- bow lakes-** In the lower course of the river the meanders are becoming very pronounced. The outer part or the concave bank is rapidly eroding so that the meander becomes a circle. A time comes when the river changes its course and the river cuts through the narrow neck of the meander. The now cut off portion of the meander looks like a crescent shape (half-moon or bow shape) and initially it has some water so called as Ox Bow Lake. Over the time it becomes a swampy and marshy area and slowly gets totally dried up as the river channel is now far away and recharge of water is not present.

Notes

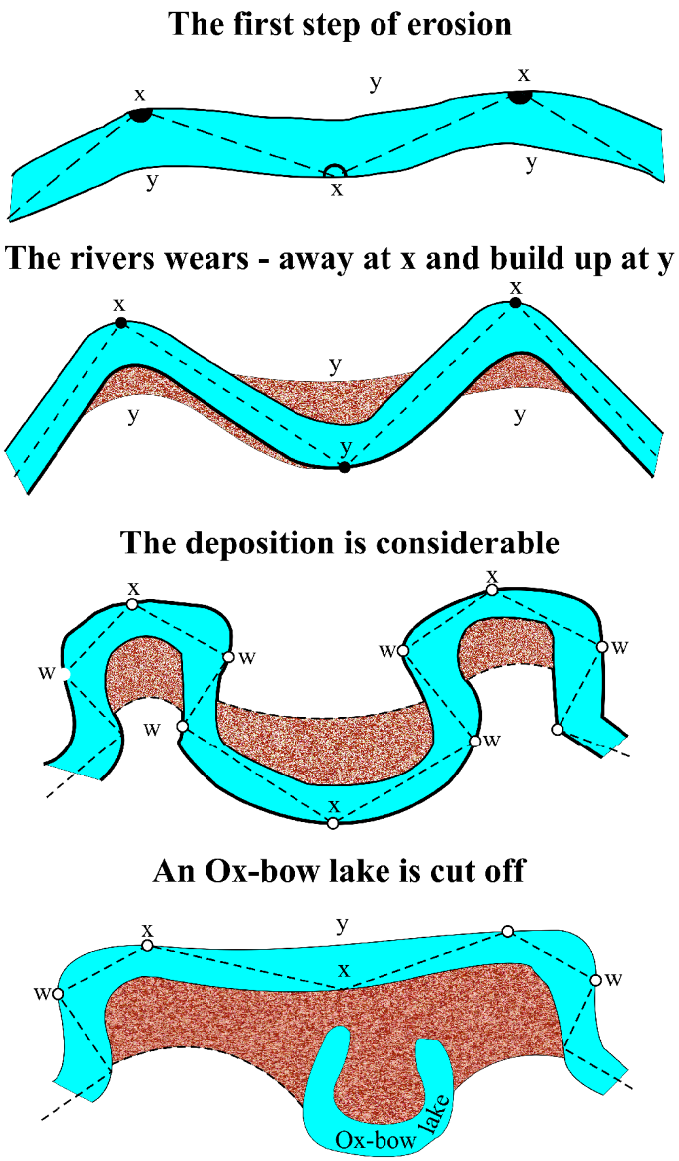


Fig 4.6 Meander and Ox bow lake (formation and shape)

vi. **Delta-** The word delta originated from Greek letter (△) which has great resemblance to river Nile delta. Delta is a triangular feature with its apex pointing up stream and has a fan shaped area of fine alluvium. The world's largest delta is made by river Ganga and river Brahmaputra known as Sundarban delta

Favourable conditions for the formation of Deltas

i. There should be active lateral and vertical erosion in the upper course of the river to provide large amounts of sediments.

ii. Shallow sea water adjoining the delta.

iii. Tideless and sheltered coast.

iv. There should be no strong current at the river mouth which may wash away the sediments.

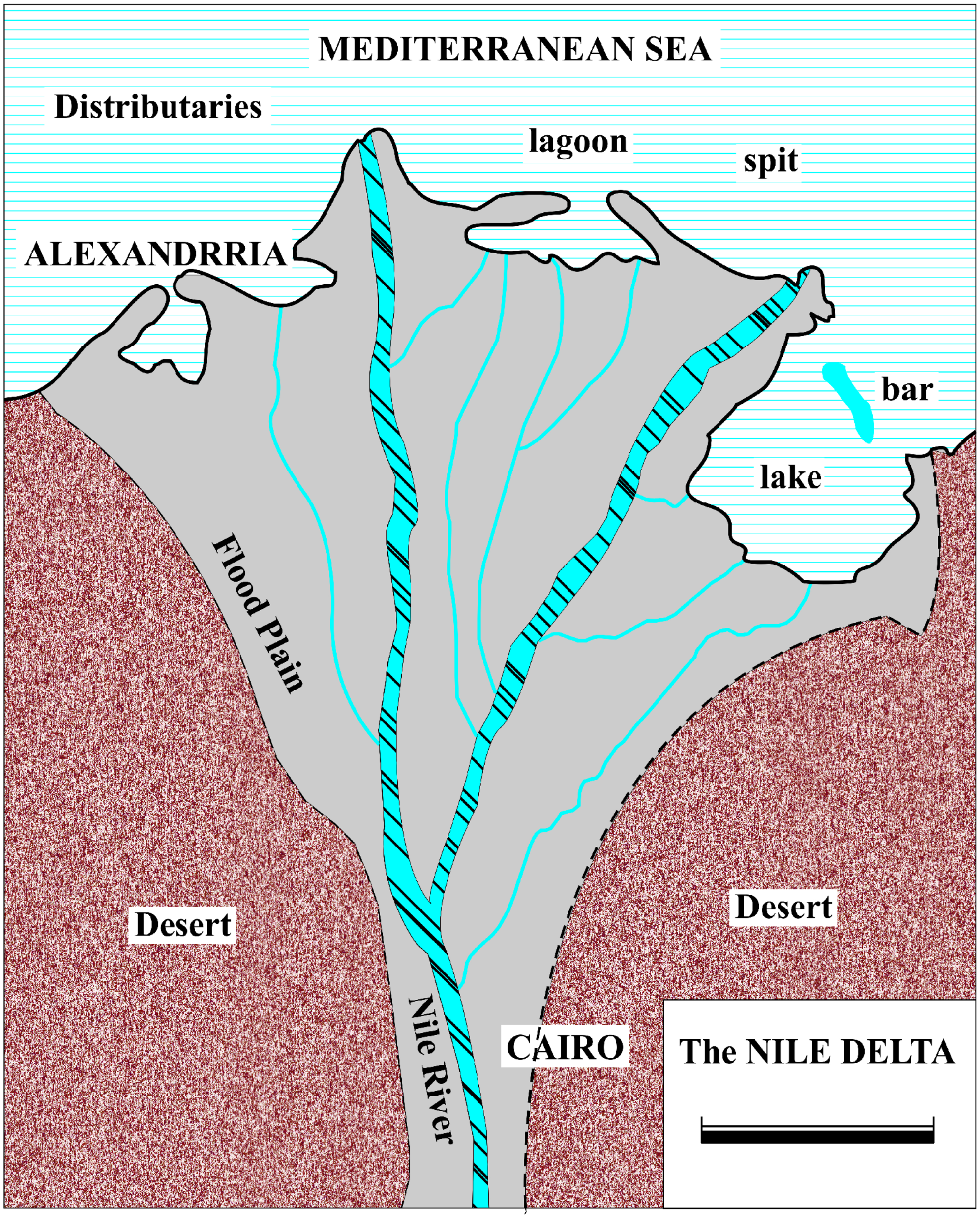


Fig . 4.7 Delta

Distributaries- In the delta region the river has deposited large loads of alluvium at the mouth of the sea. These sediments act as barriers for straight flow of river water and rivers that split into numerous channels in the delta region are called **distributaries.**

Some rivers fall from cliffs and high ridges before meeting the sea or ocean. As there is not enough flat area so rivers fall like waterfalls and form estuaries instead of deltas. **Estuaries**

are funnel shaped channels from which rivers fall into the sea and make small deposit of sediment at the beach. Two west flowing rivers Narmada and Tapi as they fall from western ghats makes estuaries before joining Arabian sea.

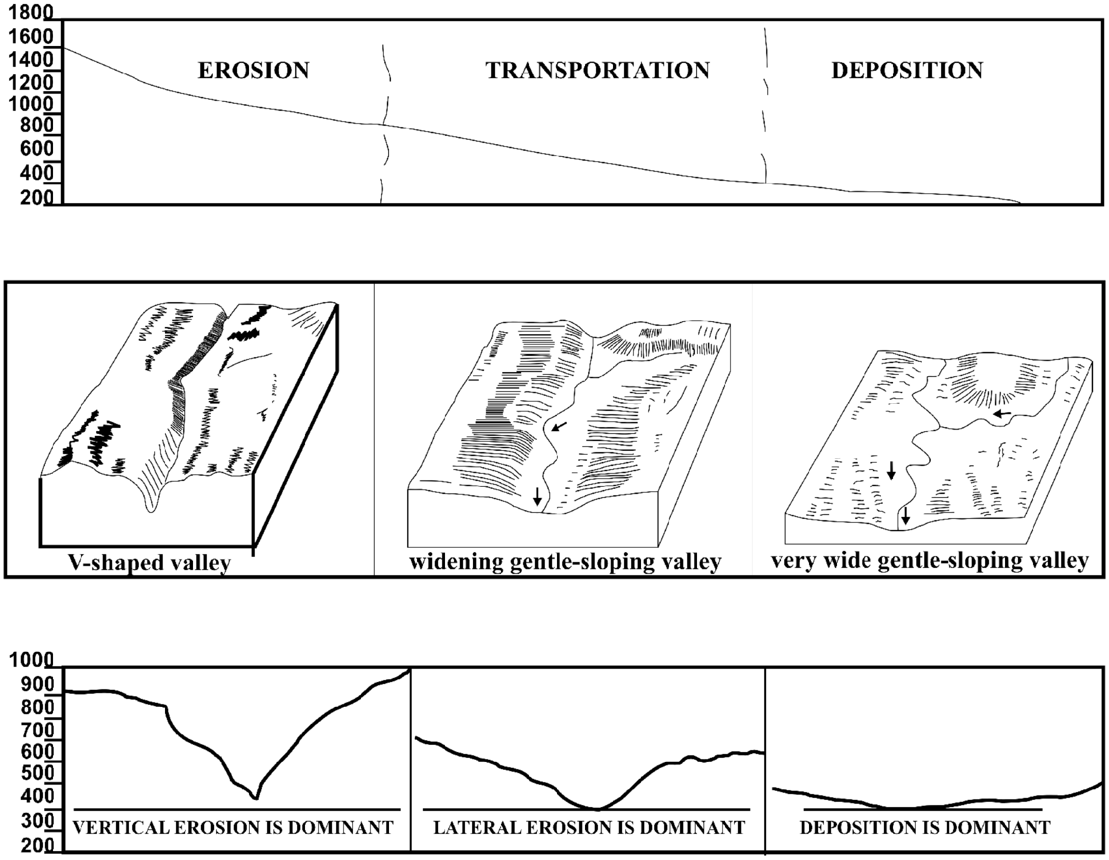


Fig. 4.8 Course of River

Significance of running water

- Rivers provide a source of freshwater.
- River water gets replenished within a short timeframe.
- Rivers carry water and nutrients from one place to another.
- Rivers play an important role in the water cycle.
- Seventy five percent of earth's surface water is drained by rivers.
- Rivers provide habitat for plants and organisms.
- River water is used for drinking, domestic, agriculture, trade and transportation, recreation and other commercial and industrial uses.
- Rivers play an important role as a renewable source of energy for e.g. Hydro power.

Notes

INTEXT QUESTIONS 4.1

1. Which are the three courses of the river?

   (i) ……………. (ii) …………………(iii) ………………

2. Name four ways by which river erosion takes place.

   (i) ……………. (ii) …………………(iii) ……………… (iv)……………..

3. Name three erosional landforms.

   (i) ……………. (ii) …………………(iii) ………………

4. Name four ways by which river transports its load.

   (i) ……………. (ii) …………………(iii) ……………… (iv)……………..

5. Fill in the blanks

   (i) The triangular shaped depositional feature formed by the river is called………....

   (ii) The meanders cut off from the main river forms a lake known as ……..............

   (iii) River Narmada and Tapi forms ………………at the west coast of India instead of a delta.

   (iv) The river splits into numerous channels at the delta are called……………...........

4.3 GLACIAL EROSIONAL AND DEPOSITIONAL LANDFORMS

Glaciers are thick masses of moving or flowing ice sometimes also called rivers of ice. The glaciers originate on land with favourable climatic conditions and compaction and recrystallization of snow where seasonal accumulation is more than seasonal melting.

Snow fields - In the regions where the temperature always remains below freezing point precipitation occurs in the form of snowfall. It's a region that displays a net annual accumulation of snow surpassing net melting rates. Wherever the rate of snow melting or its evaporation is lower than the rate of snowfall in a year the snow accumulates in great masses of ice. Permanently snow-covered areas of this type are called snow fields. Snow fields are found above the snow line and their height varies from location to location. Snowline is an imaginary line which defines the limits of snow accumulation in the snowfield above which there is continuous and positive snow cover.

DO YOU KNOW?

Snow line is the lowest limit of permanent snow cover. Various factors influence the location of snow line altitude, latitude, amount of rainfall, direction of wind, slope of the land and exposure to sunlight

In regions experiencing snowfall, the snow keeps on accumulating in the layer one above the other. Its overlying pressure makes the lower layer more granular, hard and compact. The layers of snow under pressure start turning into ice and this pressure of the overlying layers makes the solid mass of ice mobile or moving ice under its own weight is called a Glacier. Movement or velocity of the glacier is very slow and it moves from a few centimetres to few metres in a day.

The glaciers are divided into two major types according to their location or area of origin-

- Polar
- High altitude mountain areas.

Glaciers can be broadly divided into two broad categories

(i) Continental glaciers

(ii) Mountain or valley glaciers

i. **Continental glaciers -** Thick ice sheets covering vast areas of land are called as a **continental glaciers.** It is a massive accumulations of ice that covers large areas of continents and regions in polar areas. The thickness of ice in such areas can go up to thousands of metres. The glaciers of this type are built up at the centre and move outward in all directions. Continental Glacier is mainly found in Greenland (1.7 million sq. km), Antarctica (around 18.8 million sq. km) and the Arctic circle (around 15.6 million sq km). The precipitation in this region occurs in the form of snowfall each year which accumulates over these regions because the amount of melting is very less or slow as compared to the amount of snowfall received thereby covering large continental areas by glaciers. 10 percent of the land area is covered by glacial ice, ice caps and ice sheets.

ii. **Mountain or Valley Glacier** When a mass of ice from a high mountain region starts moving down in the existing valleys it is called a **valley glacier or mountain glacier**. The slope and width of the valley has an impact on the size of the glaciers. Where the valley is broad the glaciers spread outwards and where the valley is narrow glacier contracts. Fedchenko glacier situated in Central Asian Pamirs range in central Tajikistan

is the world's largest valley glacier found outside polar regions. It is about 70 kms long. Longest Glacier in India is Siachen glacier in Karakoram range which is 172 km long. Gangotri Glacier, Uttarakhand is 25.5 km long. There are many small glaciers in other parts of Himalaya and their length varies from 5 to 10-kilometres. Some of the major river of India i.e. Ganga and Yamuna originate from Gangotri and Yamunotri. Many glaciers are found in Swiss alps, Canadian Rockies and Andes Mountain ranges.

Types of landforms produced by Glaciers

Like other agents of gradation, glaciers also do the work of erosion, transportation and the deposition as glaciers require certain physical and climatic conditions for their occurrence. Most of the features created by them are found in areas affected by glacial action.

a. Erosional work of glacier

As glaciers move over the land, it drags rock fragments, gravel and sand along with it. These rock fragments become effective erosive tools. With their help glacier scraps and scours the surface rocks with which they come in contact. This action of glaciers leaves scratches and grooves on the rocks. Some of the important landforms created by glaciers are-

i. **Cirques or corrie** – Snow accumulates at the upper end of arm-chaired or bowl-shaped depressions formed at the head of the glacial valley are called cirques. The structure of the cirque has steep walls on three sides with one side open on the valley front. The cirques are like a cradle of the glacier where it is formed by plucking rock and intense freezing and thawing (causing frost shattering) from the side. It makes steep walls and scoop out at the base of the glacier in which snow accumulates and ice formations flowing away from the cirque. In certain areas the deepest part of these cirque hollows is filled with water called as cirque lakes or tarn.

ii. **"U" shaped valley-** The Glaciers do not carve out a new valley like a river but deepens and widens the pre existing valley by smoothening the irregularities. In this process the glaciers broaden the sides of the valley. The shape of the valley formed in this manner resembles the letter "U". Such a valley is relatively straight, has a flat floor and nearly vertical sides. The glacial valleys are flat bottom and steep walls caused by shear stress and glacial erosion along valley walls.

iii. **Hanging Valley**- Just like tributaries of rivers there are tributary glaciers also which join the main glaciers carve U-shaped valleys. However, they have less volume of ice than the main glaciers thus their rate of erosion is also less rapid. As a result, their valleys are not as deep as the main glacier. Due to this difference in deepening the valley of the tributary glacier is left at a higher level than the main

glacier. The valley of the tributary glacier just looks like hanging downwards at the point of its confluence with the main valley. This type of topographical feature is called hanging valley. This feature is visible when ice has melted in both the valleys. When the ice in the hanging valley melts, a waterfall is formed at the point of confluence of this stream with the main river.

iv. **Crevasses** – These are cracks which appear on the top of the glaciers and head walls of cirques.

v. **Aretes, Cols and Horns-**Aretes are saw – toothed ridges in which there are multiple ridges in series and rows and they divide two cirques. Cols are shallow passes between two high points of the mountain. They have sharp edge passes or saddles between two adjacent cirques. Horn is pyramid shaped mountain peaks which is formed by erosion on three sides by 3-4 cirques on each side of the peak. Example: Matterhorn in Switzerland.

Notes

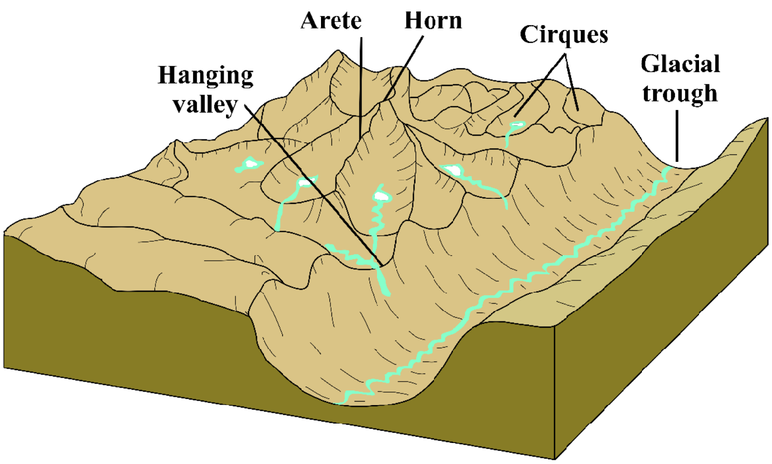


Fig. 4.9 Various glacial erosional landforms

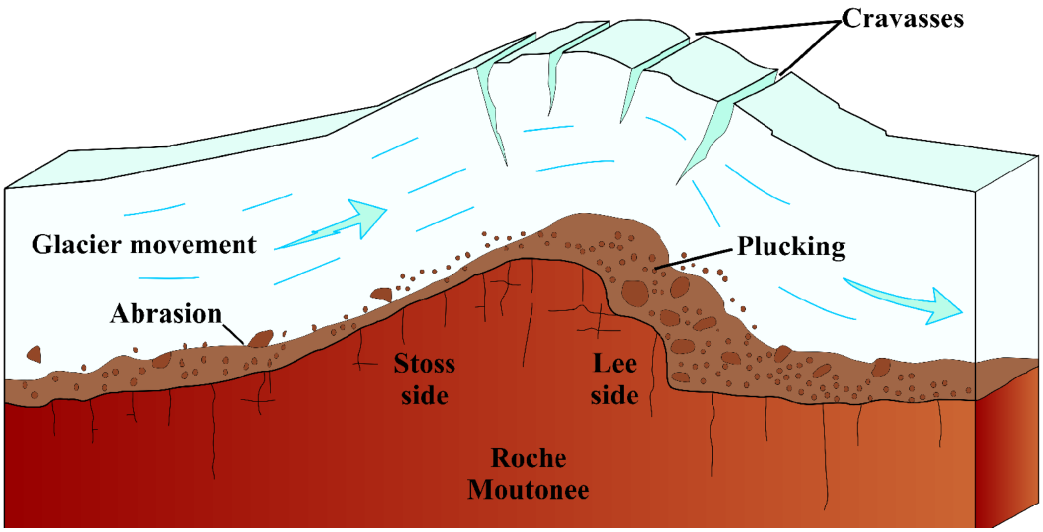


Fig. 4.10 Erosional processes of glaciers and crevasses

Fig. 4.11 Valley glacier in Sonmarg, Jammu and Kashmir, India

b. Transportation work of glaciers

Although glaciers move very slowly, it drags with it large boulders and rock fragments. Glaciers get its material from mountain slopes, valley bottom and from air. This material is called the load of glaciers.

c. Depositional work of glaciers

Eroded debris gets deposited when glacial ice melts and the sediments get deposited by moving glaciers or melt water flowing away from the glaciers. All deposits derived from glacial processes are called glacial-drifts.

Types of debris-

i. **Till**- Debris deposited directly from glacial ice constitutes poorly sorted materials like boulders, rocks and even rock flour**.**

ii. **Outwash**- Sorted and stratified debris which is deposited by melt waters. When glaciers melt or retreat, it deposits its load to different parts. The debris is directly deposited by ice, which is not sorted or layered marked by mixed of material and lack of stratification. This type of debris deposited in its glaciers is called moraines or till.

Depending upon their location in the valley moraines are of four types-

- **Terminal moraine** – This type of moraine is found along the front of the glacier and has a ridge-like structure which acts like a dam. Water accumulates between the front of the glacier and forms lakes. When the glacier melts, the debris is deposited at the end of the valley glaciers in the form of a ridge. It is called terminal moraine. The moraine material ranges from fine clay to large angular boulders.

- **Lateral moraine-** The moraine which is deposited on either side of a glacier is called lateral moraine. It is formed along the sides of the ice stream chiefly from material which are contributed from the valley sides above the glaciers by weathering, snow slides, avalanches or other types of mass wasting. Lateral moraines are frequently patchy and may and may not be present in both sides of a trough

- **Medial moraine-** When two glaciers join each other their lateral moraine also joins. Moraines thus formed on the confluence of two glaciers are called medial moraines.

- **Ground moraine-** It consists of deposits left behind in areas once covered by glaciers. It is seen only after the glacial ice has disappeared by melting.

Notes

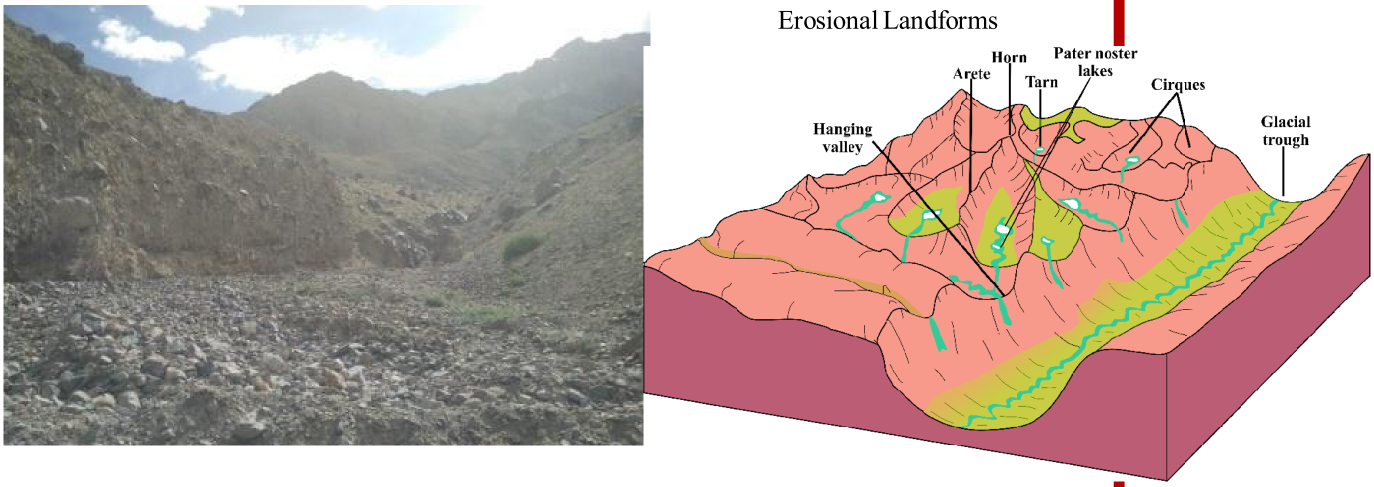


Fig. 4.12 Erosional and Depositional landforms

> ? **DO YOU KNOW?**
>
> **Sea ice, Iceberg and Glacial drift**
>
> **Sea ice-** The floating ice of the oceans is formed by direct freezing of ocean water due to extremely low temperatures in polar areas.
>
> **Iceberg-** They are mass of glacial ice floating in the ocean that has broken off a glacier and the block of ice has drifted into tidal waters. Nearly 5/6th of iceberg is submerged in water, only a very small part is visible over oceans.
>
> **Glacial drift-** It is a general term for all varieties and forms of rock debris deposited by ice sheets.

Significance of Glaciers for humans

- Glaciers ice have shaped and created many landforms in middle and high latitudes.
- Glacial ice sheets affect global climate.
- Glaciers reflect sunlight.
- Volume of ice caps and melting rate of glaciers has impacts on the sea level.
- Glacial ice affects global heat transport on earth.
- Glaciers are giant freshwater reservoirs and support life systems on the earth and also influence our day to day lives either directly or indirectly. Three quarters of all freshwater in the world is in the form of glaciers.
- They provide drinking water. Many rivers in the world originate from glaciers and snow melts. Himalayan rivers have a glacial origin.
- Melting glacial water is used for irrigation of crops.
- The cold runoff from glaciers also affects the downstream water temperatures

INTEXT QUESTIONS 4.2

1. Write two types of Glaciers on the bases of location.

   (i) .... (ii) ....

2. Fill in the blanks

   (a) The moving mass of ice and snow are called ....

   (b) The region permanently covered by snow and ice is called ....

   (c) Lowest limit of permanent snow is known as....................................

3. Identify and categorise erosional and depositional landforms made by glaciers from the given list-

   Cirques, medial moraines, 'U' shaped valley, crevasses, till, ground moraines

4. Mark as True or false

   (a) Glaciers are small reservoirs of freshwater.

   (b) Glacier lakes are made by moraines.

(c) Glacier runoff affects the downstream water temperature.

(d) Glacier melt has impact on the sea level rise.

(e) Crevasses are deposits made by glaciers.

4.3 WORKING OF SEA WAVES

The coastal zone is the part of the land surface influenced by marine processes and formed by the sea waves near by the sea. It extends from the landward limit of tides, waves, and windblown coastal dunes, and seaward to the point at which waves interact significantly with the seabed.

There are atmospheric processes including temperature variation, precipitation and winds, while the major marine processes are waves and tides, together with water temperature and salinity. The coast also supports rich ecosystems, including salt marshes, mangroves, sea grass, and coral reefs. The diverse coastal ecology is favoured by the shallow waters, abundant sunlight, terrestrial and marine nutrients, tidal and wave flushing and a range of habitat types.

There are three processes active in the Oceans; out of these the following modify the coasts:

1. Tides
2. Waves
3. Currents

Let us understand the role played by sea waves in shaping the coastline.

Erosional work of sea waves

Like rivers and glaciers sea waves also play a vital role in eroding and creating land features. Distinct processes like corrosion, abrasion, attrition and hydraulic action plays an important role in the erosion process by sea waves.

Factors affecting sea wave erosion

- **Influence of waves-** The volume of water has a great influence on the waves. Larger the volume of water, the bigger the waves created.
- **Characteristics of the coast-** Factors such as height of cliffs near the coast, their rock structure, vertical and horizontal alignment of the coast, quantity of debris along the coast on the beach also affects the sea erosion.

Coastal Processes and Landforms

Erosional and depositional landforms of coastal areas are the result of the action of ocean waves.

Erosional Coastal Landforms are formed along rugged, high-relief, tectonically-active coastlines. It includes sea cliffs, sea caves, and sea arches.

Erosional landforms

Coastal erosion is dependent on wave size, angle and frequency. They are focused where waves contact the coast.

i. Sea cliffs

They are a very distinctive feature of marine erosion. Steep rocky coast rising almost vertically above sea water is called sea cliff. The steepness of a true-vertical cliff depends on variation in geological structure, lithology relative rate of subaerial weathering and erosion of cliff face. The maximum impact of the sea waves is observed on the lower part of the cliff specially. If it is made up of soft rocks like limestone, rocks eroded more rapidly than the upper part. Most of the time upper parts are made of harder rocks and the upper part of the rock is thus left projecting out towards the sea. After some time, due to the weight of the projecting part it falls into the sea leaving behind a vertical wall which is called a cliff. Number of cliffs can be seen in Konkan coast of India.

ii. Sea caves

Waves crash into headlands eroding weaker parts such as cracks. In areas where the lower part of the coastal rock is made up of softer material and whereas the upper part is made up of harder rocks. Due to differential erosion a hollow is created in the lower part of the rock. The wave pounds against the hollow and air present inside the hollow gets compressed. When the wave comes out of the hollow air is also released and it expands. The continuous compression of the air in the hollow, the rocks are subjected to a great pressure. The crack or the hollow starts to widen in the lower part and it keeps on enlarging. With passage of time, they attain the form of a sea cave. It can be undercut causing the roof to collapse due to lack of support for the roof. This helps the cave get larger. The formation of sea caves depends upon the nature of the coastline and the force of waves.

iii. Blow hole

As the cave gets larger, waves start to hit into its back wall and on impact are sent crashing into the roof of the cave where erosion occurs.

The erosion of the cave roof can lead to a blowhole, where waves continue to erode upwards and through the top of the headland. This is quite rare and needs a vertical crack line to be exploited.

Notes

iv. Sea Arches, Stack and Needle

They are natural openings through the mass of boulder clay or limestone. Over time the waves continue to widen the walls of the arch leaving less support for the roof, leading to its collapse. This leaves a new headland on the landward side of the arch and the old wall still standing on the seaward side. This old wall is called a stack or a pillar and is also subject to erosion by the sea. As it erodes it gets thinner at its base and parts of it collapse leaving a narrower pillar called a needle.

v Wave cut Platform

Wave-cut platforms are horizontal benches in the tidal zone extending from the sea cliff out into the sea. If the sea level relative to the land changes over time (becoming lower with respect to the land due to uplift), multiple wave-cut platforms (terraces) are the result. There are emergent Coastlines Tectonic forces lift coastlines faster than sea level rises. Therefore, cliffs and marine terraces tower above the sea.

Transportation

Coastal Transportation - Wave action creates strong currents parallel to shore. Large waves move beach sand offshore. Small waves push it back on shore. The eroded material is transported by sea waves. The materials transported by sea waves are gravels, silts, cobbles and pebbles. Sometimes boulders and other marine products like minerals and plankton etc can also be transported.

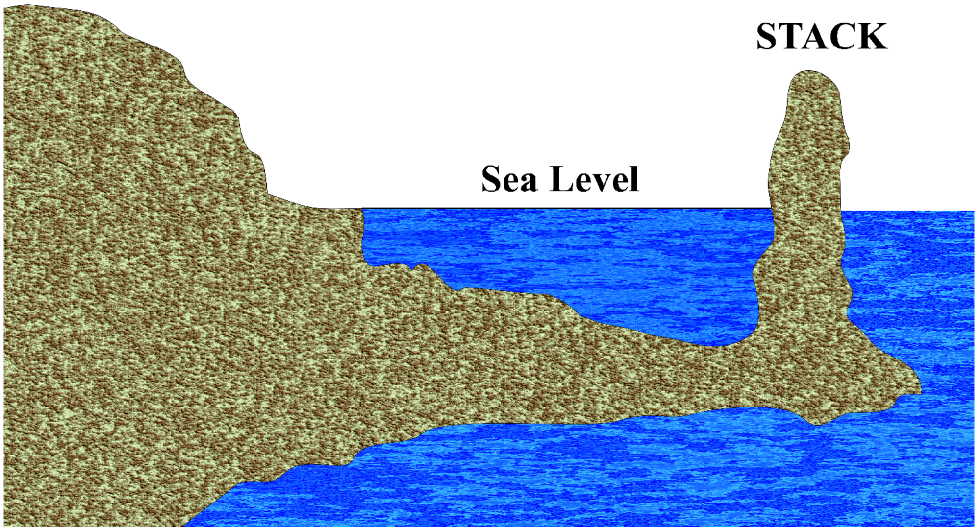


Fig. 4.13 Stack

Depositional Landforms

i. Beaches

Beaches act as natural barriers between waves and upland features, such as dunes. A beach is a narrow, gently sloping patch of land that lies along the ocean or sea. It is also found near river and lakes. They are composed of erodible, unconsolidated sand, gravel, rocks and seashells which may be moved by waves and wind. The wider and higher the beach, the more wave energy is dissipated before reaching the shoreline. Gentle, long period waves found in calmer weather, known as swells, tend to move sediment onshore, building up the beach. Steep waves associated with storms and strong winds tend to transport sediment offshore, eroding the beach. If the shore is gently sloping, wave energy can be dissipated over a longer distance, causing less erosion. Wind blowing across the beach can move finer grained particles, shaping, and, in some cases, eroding the beach. Windblown sediment will continue to move until it reaches a barrier, such as vegetation, which reduces the wind speed and causes sediment to be deposited. It is this accumulation that forms dunes. Radhanagar Beach, Havelock island, Andaman and Nicobar island; Agonda beach Goa, Marina Beach, Chennai, are a few famous beaches of India Seminyak beach, Bali, Indonesia; Santa Monica Beach, California, USA etc. are some more examples.

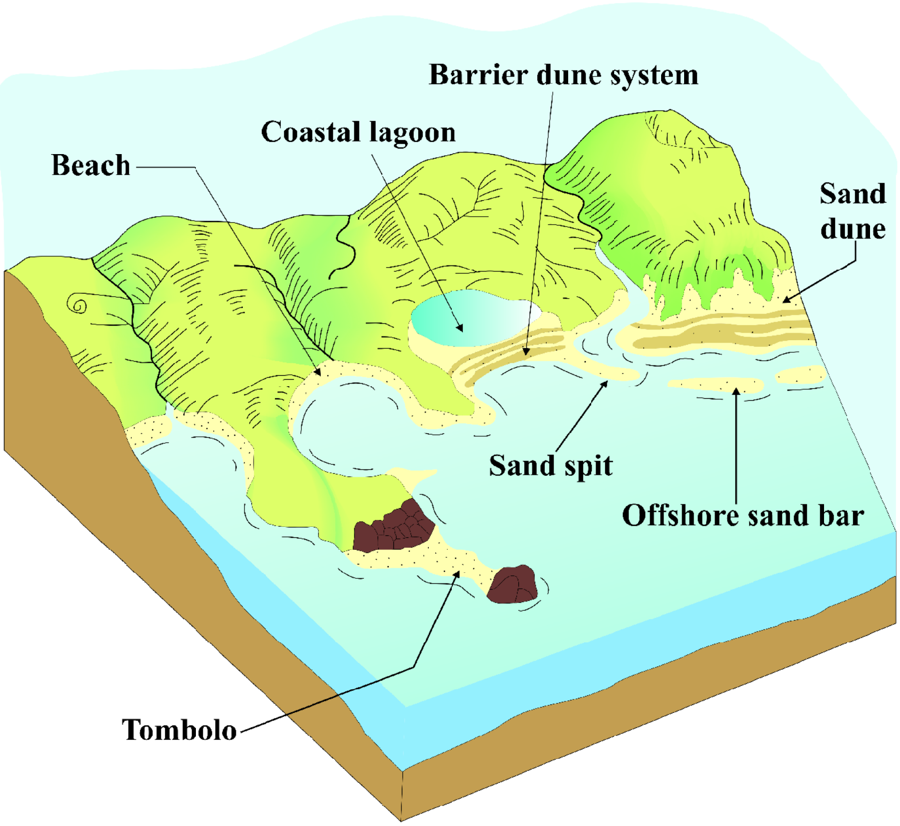


Fig. 4.14 Depositional landforms by Sea waves

ii. Offshore Bars

Offshore bars are underwater deposits of sediment that form parallel to the shoreline. They can act as wave barriers, if large enough, by forcing waves to break farther offshore than they normally would. This reduces the amount of wave energy that reaches the shore. Bars are formed from deeper water sediment, or from material carried away from a beach during times of high wave activity or higher-than-normal water levels. Spits are formed when one end of the bar is attached to the coast and the other end extends to sea. It is composed of sand and gravel brought by waves. Lagoons are formed by deposition of sediments by waves and currents on both ends of the bars thereby enclosing a part of sea water between the bar and coast. This enclosed region is filled with saline water and called Lagoon. The lagoon has a narrow passage through which it is connected by sea. Vembanad lake in west coast and Chilka and Pulicat in east coast are examples of lagoons in India.

iii. Dunes

Dunes are mounds or ridges of sand deposited by the wind immediately landward of the beach. Primary dunes are closest to the beach and are usually lightly vegetated with grasses, while secondary dunes are farther landward and may have a denser vegetation cover that can include shrubs and trees. Vegetation can trap and hold windblown sand on dunes. If large enough, primary dunes can provide protection from flooding and wave action for the upland area, and may replenish some sand to eroded beaches. If a primary dune is breached, secondary dunes (if present) provide erosion and flooding protection to landward areas.

Significance of Waves for humans

- The motion created by waves plays a vital role in transporting energy all around the globe.
- Also helps shape the coastlines.
- Ocean waves are an important element in the mechanism that controls heat balance of the planet.
- They are part of delicate balance of nature of movement of offshore and onshore by waves,
- Waves are very important for weather forecasting and for climate modelling.
- Provides resources and other benefits for the coastal communities.
- Helps in shipping industry and offshore industries,

Notes

- The waves hitting the beaches and seashores keeps earth's crust cool, especially areas which have molten lava.
- Waves also have influence on creating high and low tides which is very useful for fishing,
- Waves are useful for recreational activities like surfing etc.

INTEXT QUESTIONS 4.3

1. Factors affecting erosion by ocean and sea waves

   (i)……………………(ii)………………

2. Fill in the blanks

   (a) ………………….are underwater deposits of sediment that form parallel to the shoreline.

   (b) …………………….are horizontal benches in the tidal zone extending from the sea cliff out into the sea.

   (c) Waves are very important for weather ……………..and for ………………..modelling.

3. Rearrange the following relief features made by depositional and erosional action of sea waves-

   Sea caves, Bars, Beaches, Sea cliffs, Arches, Sea stacks, coastal dunes

4.4 WORKING OF WIND OR AEOLIAN

Wind is a powerful geological agent to create and destroy landforms. Wind is capable of eroding, transporting and depositing the surface materials. Aeolian landforms are features of the Earth's surface produced by either the erosive or constructive action of the wind. The word "Aeolian" is derived from "Aeolus", in Greek meaning, the god of the winds. In deserts, semi-arid and along sandy shorelines areas of the world where wind action moves sand and mineral particles when they are dry and the areas are without much vegetation or barriers.

Wind and its Features

Circulation of air over the earth's surface cause the wind to blow. Wind has the ability and force to lift the earth's loose particles laying on the ground surface may be lifted in air by the mechanisms like - a) Deflation b) Abrasion c) Saltation d) Deposition (as introduced in lesson 3) the turbulent eddy actions and by sandblasting of windborne particles helps in creating new Aeolian landforms.

Winds adopt three mechanisms for eroding the mass -

- Lift
- Bombardment and
- Drag

The **Lift** results from a combination of wind velocity and turbulence. There is a threshold (critical) velocity which is a function of particle size and cohesion and turbulence which changes in wind speed & direction. As turbulence increases, susceptibility of particles to lift increases.

Bombardment is the collision of moving particles with stationary ones or with solid surfaces. It has abrasion. In this process there is also collision with the solid surfaces. **Drag** also initiates sliding and rolling. It doesn't lift particles off the ground. The power of wind to erode surface particles is controlled primarily by two factors: wind velocity and surface roughness. Erosive force increases exponentially with increases in wind velocity. The power of wind to erode surface particles is controlled primarily by two factors: wind velocity and surface roughness. Erosive force increases exponentially with increases in wind velocity.

Desert environments are characterised to assist in wind erosion by following ways -

a. Very low mean annual rainfall of less than 50 mm

b. Absence of vegetation

c. Very high daily and annual range of temperature

d. Dust storms

e. High velocity winds and

f. Dominance of sands

Erosion by Winds

Winds are the most widespread geomorphic agents in the deserts, arid and semi-arid regions. Wind erosion generally takes place above the ground and thus wind velocity plays a major role in determining the degree of Aeolian erosion. Wind erosion is effective only up to 180 cm above the ground surface. Maximum wind erosion occurs at short distances. Unlike rivers and glaciers, winds erode the rocks from all sides because of their variable directions.

Some of the erosional landforms of the wind are:

i. Blow Outs or deflation basins

Rocks that are exposed to the sand blasting of prevailing winds become pitted, grooved, and polished. Deflation basins, called blowouts, are hollows formed by the removal of

particles by wind. Sand grains are rolled and the entire bed is lowered, in some cases up to one metre, resulting in shallow depressions called blowouts. This depression may be a few metres to as much as a kilometre across. Depressions are formed in the deserts due to removal of sands to a greater extent. The size of the depressions varies from small hollows to big hollow deeps. A desert pavement is a typical desert surface. It is covered with closely packed, interlocking angular or rounded rock fragments of pebble and cobble size, formed by the gradual removal of the sand, dust and other fine grained material by the wind and intermittent rain. The Qattara Depression of Egypt is the best example.

ii. Yardangs

Yardangs are elongated ridges formed wind oriented with the prevailing winds. Yardangs are larger hill-sized features sculpted by the wind. Yardangs are composed of cohesive silts and clays, sandstone, or limestone. They develop in regions with strong unidirectional winds.

iii Mushroom rock

When the composition of rock is mixed where there are alternate layers of soft and hard rock the rock is subjected to wind abrasion with differential erosion results. More sediment load is carried by wind at lower heights so erosion is more at the base or near base of the rock. The upper blowing winds carry less sediment load as it becomes heavy to carry so erosion at the upper part of the rock is less. This gives the mushroom rock its famous shape of top and base thin. These rocks resemble rock pillars shaped like mushrooms. Such types of formation can be seen in Sahara Desert in Africa and Thar desert in India.

Features made by deposition

Aeolian or wind deposits are distinguished from other continental deposits by a number of specific features. They are:

a. Irregular cross-bedding

b. Gentle dipping

c. Steep and

d. Orienting in different directions making different shapes.

The grains of Aeolian sands are generally well-rounded due to prolonged transportation by wind. Sometimes, they are well-polished. The depositional landforms of wind are:

i. Ripple marks

Ripple marks are very small features produced in unconsolidated sediments or sand dunes at right angles to the wind direction. They stretch laterally for long distances. Ripple marks are produced where there is some irregularity on the surface. Sand ripples develop transverse to the wind direction. Their wave-length is hardly 1 metre. When there are stronger winds blowing the ripple marks can vanish.

ii. Sand dunes

Landform is created by the movement of sand by wind. The dunes are like small mounts, ridges or hills. Sand dunes are a very prominent feature of desert areas. The coarser materials are deposited in drifts in the shape of crest or definite summit or hills or ridges, called dunes. An ideal dune has a long windward slope rising to a crest and a much steeper leeward slope. A sand dune may be defined as a mound or ridge of wind-blown sand, rising to various heights up to 50 m. It is found in hot deserts and above high-water mark on low-lying coasts where sand is constantly renewed by onshore winds blowing across the sandy beaches. Desert sand dunes are generally characterised by the absence of natural vegetation.

For dune formation certain conditions are necessary such as,

(i) a fairly continuous sand supply;

(ii) a constant wind strength and direction; and

(iii) an obstacle or series of obstacles to trap the sand.

Types of Sand dunes

Some of the major types of sand dunes are;

a. **Barchan -** They are crescent (half-moon) or arc-shaped, appear convex in shape and are primarily formed by wind from one direction. Most common type of sand dune and found in sandy deserts all over the world. Two "horns" face downwind on this type of dune, with the steeper slope known as the slip face facing away from the wind.

b. **Transverse dunes-**Transverse dunes are asymmetrical in shape, and from where light to moderate winds blow from a constant direction. These dunes take the shape of a series of crests and troughs whose peaks are perpendicular to the direction of prevailing winds. These dunes appear like sea waves.

c. **Seif or longitudinal dunes-** They are long narrow ridges that are parallel to the direction of prevailing winds. The winds come from different directions. The winds blow straight along the corridors between the lines of sand dunes and sweep the corridors clear of

Notes

sand. Narrow rows elongated which could be many hundred kms long but their troughs the lower portion is almost without sand and some can reach height up to 100 mts. Such types are commonly seen in the Sahara Desert, North Africa, Arabia and can also be seen in western part of the Thar desert of India.

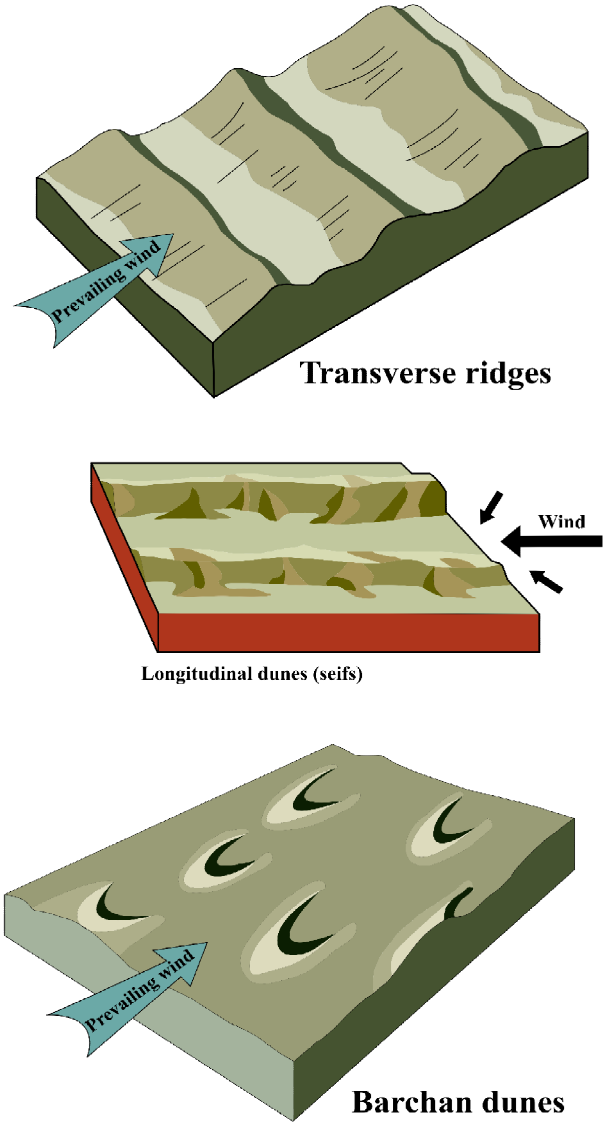


Fig. 4.15 Types of Dunes

iii. Loess

It primarily located close to desert floor or crust. The word originated from German word Loess which means loose or un- consolidated. The particles are silt-sized and yellow in colour the deposits are very thick and have homogenous unstratified silt deposits. They are made up of fine loamy soil with high contents of lie. They are very porous and

very cohesive and water seeps in the subsurface very rapidly and the top surface is always dry. The loess areas are very soft so when roads are constructed in these areas witness frequent sinking of the soil and roads also sink with it. For eg extensive deposits in northwest plateau region of China the thickness can be 30 m deep commonly but can reach up to 100 m. The material is so loose that it is picked up my winds from central Asia to far flung regions in South and Southeast regions.

Significance of Wind for humans

- Wind increases the turbulence in atmosphere.
- Movement of water vapour, clouds and various forms of precipitation so winds allow humidity to occur.
- Winds also helps in circulation of various gases for example providing supplies of carbon dioxide resulting in greater rates of photosynthesis and oxygen movement for direct consumption by the humans.
- Winds also help in generating renewable sources of energy in the form of wind energy through wind mills. Wind energy is used for various purposes like electricity, milling grains, water pumping etc.
- Winds also help in sailing ships and aeroplanes.
- Winds provide sea breezes (winds move from sea to land) and land breezes (winds move from land to sea.
- Winds help in plants pollens to move from one place to other and also assists in flight of birds.

INTEXT QUESTIONS

1. Name three mechanism of wind erosion.

   (i) .... (ii)...................... (iii)............................

2. Name major erosional landforms created by action of wind.

   (i) .... (ii)...................... (iii)............................

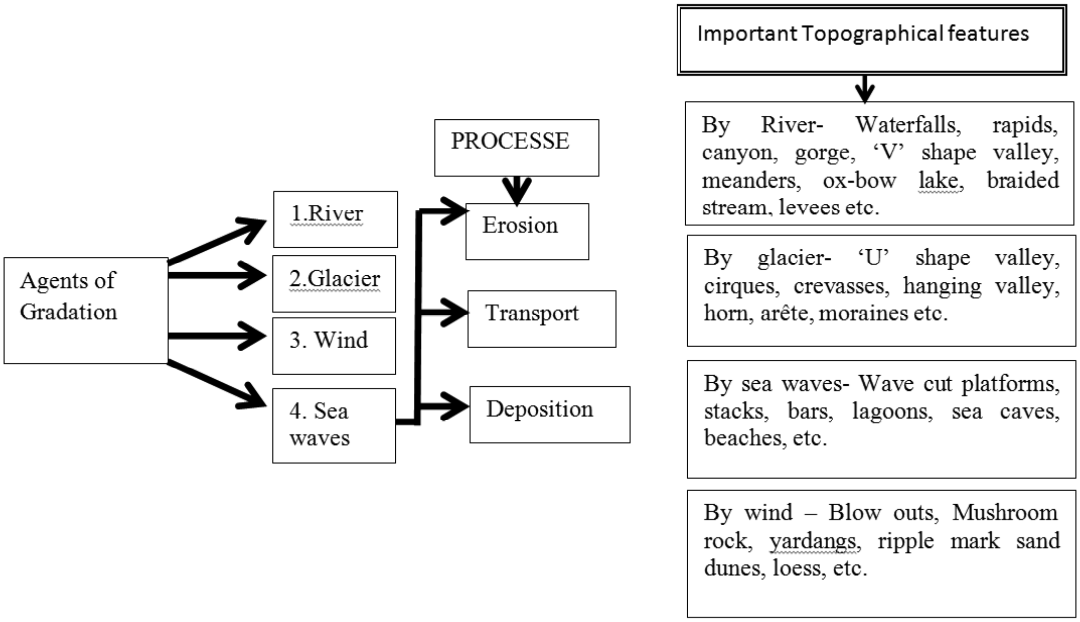
3. Name major depositional landforms created by action of wind.

   (i) .... (ii)...................... (iii)............................

4. In which regions of the world maximum deposits of loess found?

....

WHAT YOU HAVE LEARNT



TERMINAL QUESTIONS

1. Explain any three topographical features made by erosional work of rivers.
2. What is the difference between estuary and delta?
3. Differentiate between following
   (a) 'U' shaped and 'V' shaped valleys
   (b) Flood plain and braided streams
   (c) Lagoon and bars.
4. With the help of diagrams explain ox-bow lake, delta and natural levee.
5. Define glaciers. Distinguish between continental and valley glaciers.
6. What is a hanging valley? How are hanging valleys different from 'U' shaped valleys ?
7. What are moraines? Elaborate various types of moraines.

8. Explain two major factors affecting sea wave erosion.

9. Discuss formation of beaches and give two examples of beaches in India.

10. Describe favourable conditions in the desert environment assisting in wind erosion.

ANSWERS TO INTEXT QUESTIONS

4.1

1. (i) Upper course
   (ii) Middle course
   (iii) Lower course
2. (i) Abrasion or corrasion
   (ii) Corrosion or solutions
   (iii) Hydraulic action
   (vi) Attrition
3. (i) 'V' shaped valley
   (ii) Waterfalls and rapids
   (iii) Gorges and canyons
4. (i) Traction
   (ii) Saltation
   (iii) Suspension
   (iv) Solution
5. (a) Delta
   (b) Ox-Bow Lake
   (c) Estuaries
   (d) Distributaries

4.2

1. (i) Valley or mountain glaciers

   (ii) continental glaciers

2. (a) glaciers

   (b) snow- field

   (c) snow-line

3. Erosional features-cirques, 'U' shaped valley, crevasses
   Depositional features- medial moraines, till, ground moraines

4. (a) False

   (b) False

   (c) True

   (d) True

   (e) False

4.3

1. (i)) Influence of waves

   (ii) Characteristics of the coast

2. (a) Offshore bars

   (b) wave-cut platform

   (c) forecasting, climate

4.4

1. Name three mechanism of wind erosion

   (i) Bombardment

   (ii) Drag

   (iii) lift

2. Name major erosional landforms created by action of win
   - (i) Mushroom rock
   - (ii) Blowouts
   - (iii) Yardangs
3. Name major depositional landforms created by action of wind
   - (i) Dunes
   - (ii) Loess
   - (iii) Ripple marks
4. In which regions of the world maximum deposits of loess found-
   Extensive deposits in northwest plateau region of China

MODULE -3

The Domain of the Water on the Earth

5. Hydrological Cycle and Ocean

5

HYDROLOGICAL CYCLE AND OCEAN

Water is the most important life supporting element of planet earth. Without water, survival in the entire earth is not possible. Almost 72% of the earth's surface is covered with water. The water on earth is present as solid form (ice), liquid and gas (water vapor). In the present scenario across the globe, the consumption of freshwater and underground water has increased to the greater extent due to the large population. Water is the crucial element of our domestic, agricultural and industrial economy.

In previous lesson we came across the significance of running water, moving ice wind and sea waves for humans. In this lesson we will discuss hydrological cycle, water budget, ocean relief, temperature and salinity, waves, tides and currents.

OUTCOMES

After studying this lesson, learner:

- explains the importance of oceans, the hydrological cycle and water budget on the earth;
- differentiates various relief features;
- analyses the vertical and horizontal distribution of temperature and salinity and its determining factors and
- describes the three types of ocean movements-waves, tides and ocean currents;

Notes

5.1 IMPORTANCE OF OCEAN IN LIFE

Oceans are responsible for producing half of the world's oxygen. It also absorb more than 50 percent of carbon dioxide of our atmosphere. Oceans regulate climate. It covers 70 percent of the Earth's surface thus transporting heat from equator to the poles. It provides home to number of species

5.2. HYDROLOGICAL CYCLE

Hydrology is the scientific study that deals with the movement of water on earth surface and its beginning can be traced at any of the processes i.e. evaporation, condensation, precipitation, interception, infiltration, percolation, transpiration, runoff, and storage.

It is well evident that there is a cyclical process of different physical formations on Earth surface. Water also undergoes such cyclical processes. The water cycle is the journey that water makes in its life. Water changes from one state to the other that is from solid to liquid, liquid to gaseous state and vice versa. Water is the cyclical resource of earth surface. It not only changes its form but also from one place to another that is ocean to land or land to ocean etc. There is no starting point as the word 'cycle' suggests. This means that there is no beginning and no end and no fixed path.

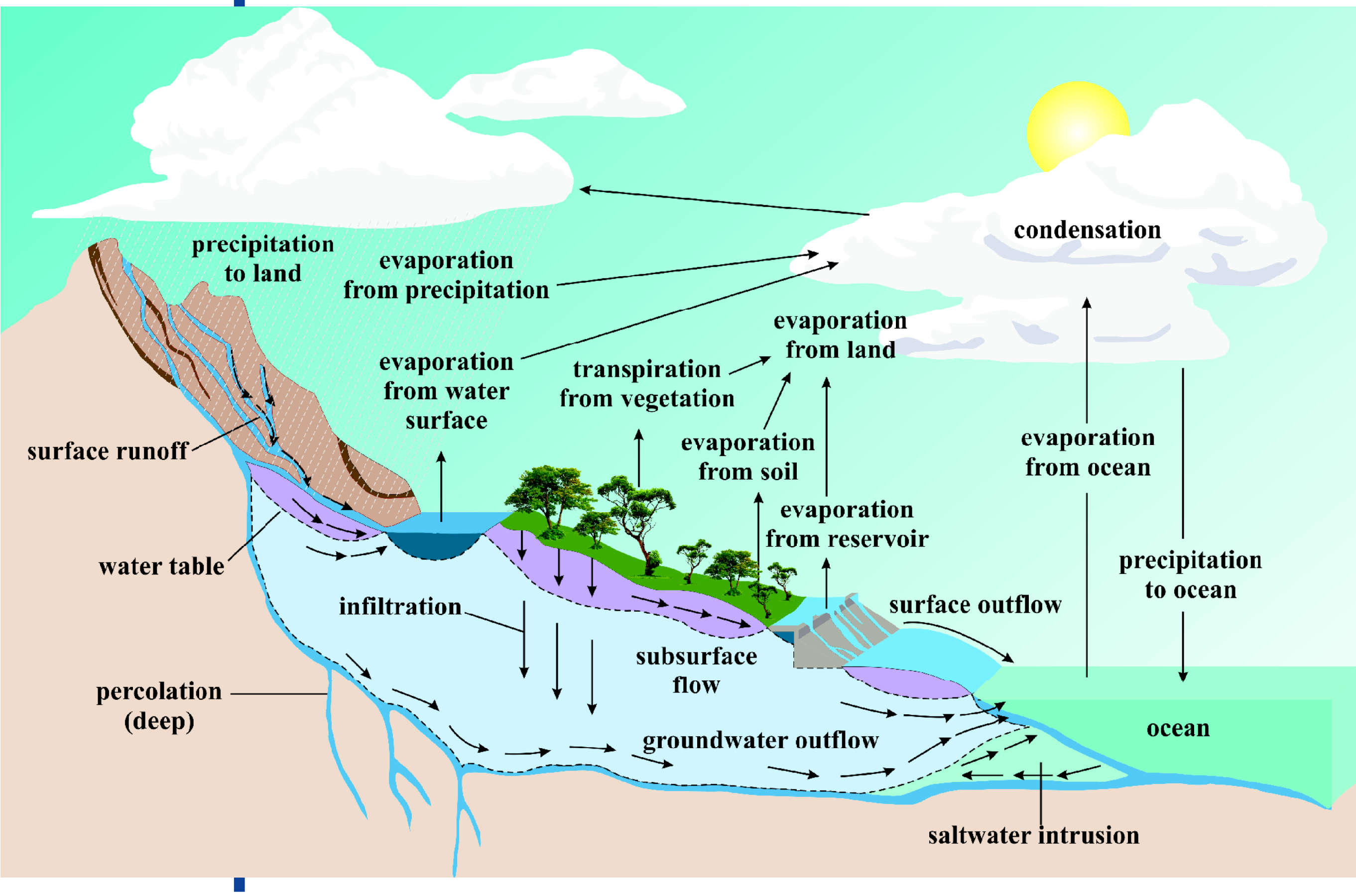


Fig. 5.1: Hydrological Cycle

Notes

Let's know some of the important processes of hydrological cycle:

a. **Evaporation:** Evaporation is the process through which water changes from liquid state to the gaseous state due to increase in temperature and pressure. It is one of the fundamental processes of water cycle. Water stored in ocean moves to the atmosphere through evaporation or evapotranspiration.

b. **Condensation:** Condensation is the process by which water from gaseous state changes into its liquid state i.e. cloud .It is the opposite of evaporation. This state is also known as cloud formation state. Low temperature is required for condensation to happen. Water in the gaseous state is condensed to form cloud.

c. **Precipitation:** Water that got condensed to form cloud gets accumulated in atmosphere in different forms and that accumulated water comes back to land surface in form of snow, rain, sleet, fog and hail due to the increased velocity and force of gravity.

d. **Evapotranspiration:** Evapotranspiration is the process by which water is transferred from the land to the atmosphere by evaporation from the soil and by transpiration from plants. Evapotranspiration accounts for about 10 percent of vapor in the atmosphere.

e. **Transpiration:** Transpiration is the process by which water from the plant surface gets evaporated and gets changed into gaseous form due to change in temperature, humidity and pressure.

f. **Runoff:** Runoff is the form of precipitation that does not get infiltrated or absorbed by soil and it gets collected to form ponds, seas and oceans. Runoff is one of the major causes of soil erosion and it also carries lot of chemicals thus causing water pollution.

g. **Infiltration:** The process of the absorption of the precipitated water is known as infiltration. Water gets absorbed by soil and also runs through pores and spaces in the land surface. Water can be absorbed by the soil and stay in the soil for a long time and gradually gets evaporated. In the area with a lot of green plants the infiltrated water gets absorbed by plant roots and later gets transpired. Infiltration occurs in the upper layers of the ground but may also continue further downwards into the water table.

h. **Groundwater Hydrology:** Water below the surface of Earth, occupying all or part of the void spaces in soils or geologic strata is Groundwater. Both surface and groundwater are related through the hydrologic cycle a cyclical process in the Earth-atmosphere system. Flow of ground water depends upon porosity of the soil and its permeability.

i. **Porosity and Permeability: Porosity** is the measurement of the open space within the rocks. This space can be between grains or within cracks or cavities of the rock. It depends on size of sediments, shape of sediments and sorting of

sediments. **Permeability** is the measurement of the ease through which fluid (water) can move through a **porous** rock.

j. **Aquifer:** The underground layer of permeable rock, rock fractures or unconsolidated materials which bear the water is known as an aquifer. We can extract groundwater by using water well. The study of the flow of aquifers is known as hydrogeology.

Importance of hydrological cycle

- Precipitation is essential for the growth of plants.
- Infiltration is essential for cleaning water and also helps in filtration.
- Glaciers, ice, and snow can act as stores of freshwater for both humans and other organisms.
- Runoff contributes to rivers, other freshwater bodies, and eventually the ocean, sustaining freshwater and marine life.

All of these processes sustain life and create the ecosystems around us.

Water Budget

A water budget provides a ground for evaluating availability and sustainability of a water supply. A water budget simply states that the rate of change in water stored in an area, such as a watershed, is balanced by the rate at which water flows into and out of the area.

INTEXT QUESTIONS 5.1

1. What is Porosity?
2. Define water budget?
3. Name any two the processes involved in the hydrological cycle?
4. What are Aquifers?

5.3 OCEAN RELIEF: MAJOR OCEAN RELIEF FEATURES

Ocean relief is an outcome of tectonic, volcanic, erosional and depositional processes and their interactions. The ocean basins have features similar to the topography of the land surface.

The two broad categories of ocean relief are **major relief features** and **minor relief features.**

Notes

a. Major relief features

The major relief features of the oceans are divided into four.

i. The Continental Shelf

ii. The Continental Slope

iii. The Continental Rise

iv. The Deep Sea Plain or the Abyssal Plain

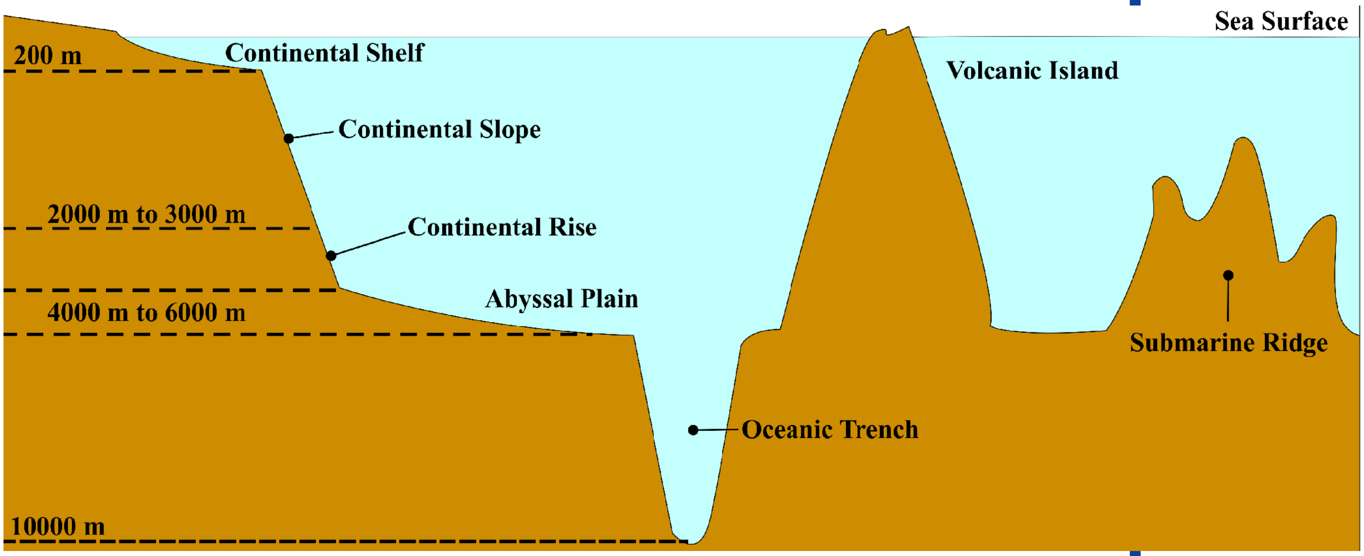


Fig. 5.2 Major Ocean Relief

i. **The Continental Shelf**- The Continental Shelf is the continental margin which starts from the shoreline and extended upto the continental edge. The reasons for the formation of shelves are:

- Submergence of a part of a continent,
- the relative rise in sea level,
- sedimentary deposits, smaller continental shelves could have been caused by wave erosion where the land is eroded by the sea. Continental shelves covers an area of 7.5% of the total area of the oceans and 18% of earth's dry land area. The average width of the shelf is 70 -80 kms.

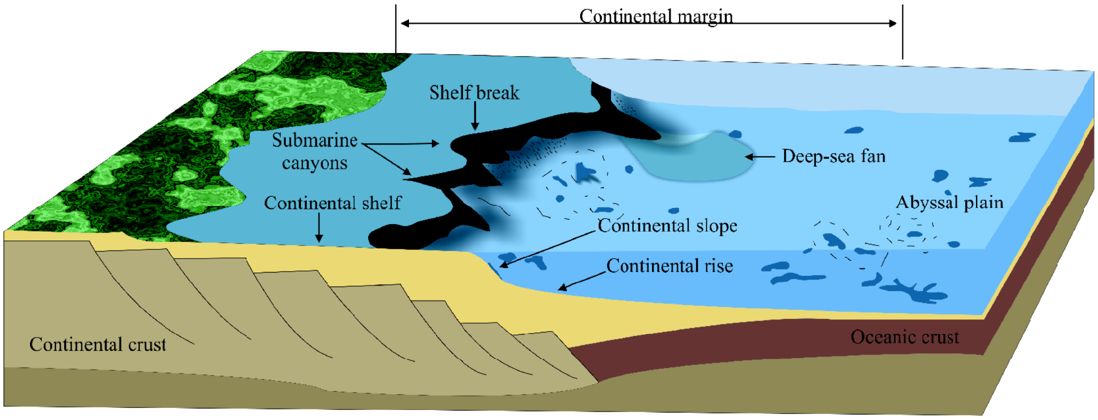


Fig. 5.3 Ocean Relief Features

The significance of Continental Shelves- Continental Shelves are economically and ecologically significant. It is one of the most accessible part of the ocean. Shelves provide conditions for the growth of millions of plankton and microorganisms through penetration of sunlight which makes them excellent breeding ground for fish. Hence continental shelves are the richest fishing grounds in the world. Marine food almost comes entirely from continental shelves. It is also the source of Fossil fuels and leads to the formation of metallic and non metallic ores.

ii. **The Continental Slope-** We can see as the continental slope is the connection between continental shelf and continental rise. The end of the Continental shelf is marked by the sharp increase in the slope. From this point, continental slope starts. There is an abrupt change in the gradient to about 1 in 20. The gradient of the slope is highest off coasts with young mountain ranges and narrow continental shelves and lowest off stable coasts without major rivers. Canyons are also found in this region.

iii. **The Continental Rise-** The Continental Rise is the link between Continental slope and the deep sea or abyssal plain. The steepness of continental rise is lower than that of the continental slope and it gradually merges into the deep sea plain. It is a major depositional regime in oceans made up of thick sequences of continental material that accumulate between the continental slope and the abyssal plain.

iv. **The Deep Sea plain or the Abyssal plain-** Abyssal plain are the sloping areas of the ocean basins. It is considered to be flattest and smoothest regions of the world. These plains are covered with sediments like clay and slit.

b. Minor Relief features:

i. **Ridges:** The underwater mountain formed by plate tectonics (divergent boundaries) is known as mid-oceanic ridges. These mountains are separated by a large depression

ii. **Seamounts:** It is a mountain with pointed summits, rising from the seafloor that does not reach the surface of the ocean. Seamounts are volcanic in origin. These can be 3,000-4,500 m tall.

iii. **Guyots:** The flat-topped mountains (seamounts) are known as guyots.

iv. **Trenches:** Trenches are relatively long, steep-sided, narrow basins. These areas are the deepest parts of the oceans. They are originated by plate tectonic and are formed during ocean-ocean convergence and ocean-continent convergence. The greatest known ocean deep, the Mariana Trench is nearly 36,000 feet deep and found near Guam Island in the Pacific Ocean.

v. **Coral reefs:** Coral reefs are built by colonies of tiny animals found in marine water that contain few nutrients. They are diverse underwater ecosystems held together by calcium carbonate structures secreted by marine invertebrates called corals.

vi. **Atolls:** The low islands found in the tropical oceans consisting coral reefs surrounding a central depression is known as Atoll. It may be a part of the sea (lagoon), or sometimes part of a body of fresh, brackish, or highly saline water. Example: Lakshadweep is formed on Atolls.

INTEXT QUESTIONS 5.2

1. What is the continental slope?
2. Name the minor relief features of the ocean?
3. What are the major relief features of the ocean?
4. Define trenches?
5. Which Island in India is form of Atolls?

5.4 OCEAN TEMPERATURE AND ITS DISTRIBUTION

Water has the highest capacity of absorbing heat. About 80 percent of heat is absorbed by oceans. The uppermost 10 percent of the oceans contain more heat than the entire atmosphere.

Notes

There is a variation in distribution of temperature in oceanic water. It differs from latitude to latitude and from the surface to the bottom.

The major determinants of ocean temperature are:

- **Latitude:** The surface temperature of the oceans declines from the equator towards the poles as the Sun's rays are vertical on the equator.
- **Prevailing Winds:** Direction of the prevailing winds such as the Trade Winds, Westerlies etc., determines the surface temperature of ocean waters at a point.
- **Unequal distribution of Land and Water:** The Northern Hemisphere has more land area than that of the Southern Hemisphere. Hence, the oceans of the Northern are warmer than that of the Southern Oceans.
- **Evaporation Rate:** Highest amount of water is gets evaporated from oceans. However, there is no uniformity in the rate of evaporation. The warmer region experience more evaporation than cooler one.
- **The density of water:** The density of ocean water is governed by the temperature and salinity. There is variation of density of water from latitude to latitude. Areas with high salinity witness the relatively higher temperature of ocean waters and vice versa.
- **Ocean Currents:** The temperature of oceans of surface is also controlled by cold and warm currents. The presence of warm water increases the temperature and thus raising the rate of evaporation. Therefore, the region records more rainfall, while the cold current reduces the temperature of the moisture-laden wind.
- **Local Factors:** Submarine ridges, local weather conditions like storms, cyclones, winds, fogs, cloudiness, the rate of evaporation, lapse rate, condensation, and precipitation are some of the major factor that affect ocean temperature.

a. Horizontal Distribution of Temperature

The usual temperature of the surface water in the lower latitudes is about 26° Celsius which decreases towards poles. The oceans of the Northern Hemisphere record an average temperature of 19.4° Celsius. However, the average temperature recorded at various latitudes also varies with 22° Celsius recorded at 20° latitude, and 14° Celsius recorded at 40° latitude in the Northern Hemisphere. At the poles, the temperature drops to 0° Celsius.

The maximum and minimum annual temperatures of ocean water in the Northern Hemisphere are in the months of August and February respectively. The average annual range of temperature is about 12 degrees Celsius. The highest annual range of temperature is recorded in the North Atlantic Ocean. Moreover, the annual range of temperature is higher for the inland seas as compared to the open oceans.

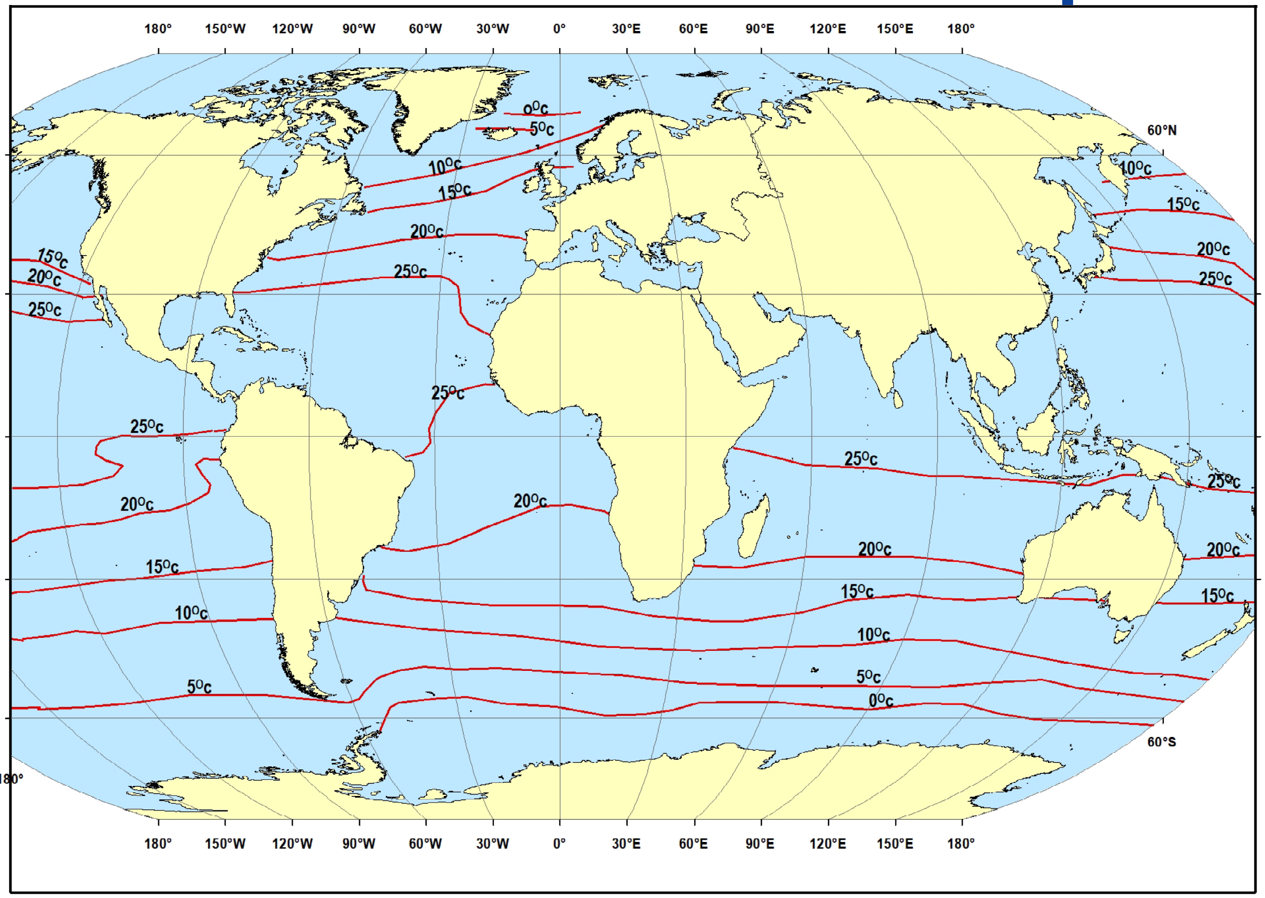


Fig. 5.4: Temperature Distribution in the Oceans

b. Vertical Distribution of Temperature

With the increased depth in the oceans both energy and sunlight decreases. Only about 45 percent of light energy striking the ocean surface reaches a depth of about one meter, and only 16 percent reaches a depth of 10 meters. On the basis of the temperature, the ocean depths may be divided into the following three zones:

- **Surface Zone or Mixed Zone:** This is also known as the Photic zone or Euphoric zone. It is the upper layer of the ocean. In this layer, the temperature and salinity are relatively constant. It contains about 2 percent of the total volume of water in the ocean. It is limited to a depth of about 100 meters.

- **Thermocline:** It lies between 100 metres and 1000 metres. It contains about 18 percent of the total volume of water in the ocean. There is a steep fall in temperature in this zone. The density of water increases with increasing depth.

- **Deep Zone:** This zone lies below 1000 metres in the mid-latitudes. This zone contains about 80 percent of the total volume of water in the ocean. The temperature in this zone remains constant. The ocean bottom always has a temperature which is one or two degrees Celsius above the freezing point.

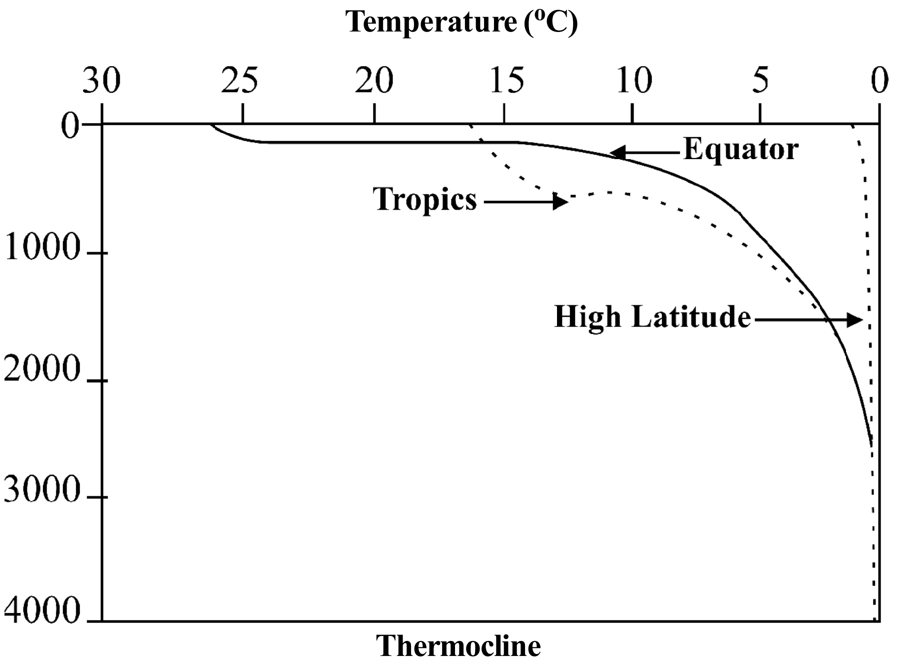


Fig. 5.5 Distribution of Temperature

INTEXT QUESTIONS 5.3

1. What are the major determinants of Ocean temperature?
2. How prevailing winds determines surface temperature of Ocean waters?
3. What is the average annual range of temperature of ocean?
4. Name the three zones in which ocean is divided on the basis of temperature.
5. Define thermocline zone.

5.5 OCEAN'S SALINITY AND SALT BUDGET

The salinity of ocean waters is measured by the amount of dissolved solids present in a unit weight of ocean water, usually expressed in parts per thousand by weight or grams per kilogram.

Salinity of Ocean

The salinity of ocean water is usually around 35 parts per thousand on an average at zero degrees Celsius. This implies that in the total weight of ocean water, dissolved salts amount to 3.5 percent. Sodium chloride or the common salt is the most common among all the dissolved salts in the sea.

Table 5.1: The chemical composition of ocean water

Salt	Percentage
Sodium chloride	2.6
Magnesium chloride	0.3
Magnesium sulphate	0.2
Calcium sulphate	0.1
Potassium chloride	0.1
Potassium bromide	0.01
Other elements	0.01

Sources of salinity

The source of salts dissolved in the ocean waters has their origin on the continental landmasses. They are carried into the oceans by rain, rivers, groundwater table, sea-waves, winds, and glaciers. Some of the dissolved salts are originated from the ocean bottom. The layers of the earth beneath the crust contain minerals in a molten state which can reach the crust either due to volcanic activity or due to their continuous emission in the form of gasses.

Determinants of the salinity of the oceans

Ocean salinity is dependent upon several factors and it keeps varying with the place and time. The major determinants of ocean salinity are-

- **Evaporation:** Salinity is usually higher at places with high rates of evaporation. i.e. the tropical seas such as the Red Sea, Persian Gulf etc.
- **Temperature:** Temperature and ocean salinity are directly proportional to each other. Generally, regions with high temperatures are also the regions with high salinity.
- **Precipitation:** Precipitation and salinity inversely proportional to each other. Hence regions with higher levels of precipitation have lower levels of salinity.

- **Ocean Currents:** Ocean currents plays crucial role in the spatial distribution of dissolved salts in ocean waters. The warm currents near the equatorial region push away the salts from the eastern margins of the oceans and accumulate them near the western margins. Similarly, ocean currents in the temperate regions increase the salinity of ocean waters near the eastern margins.

- **The influx of Fresh Water:** Salinity is relatively lower in areas where major rivers meet the oceans.

a. Horizontal Distribution of Salinity

The surface salinity of oceans decreases on either side of the tropics. For example, the surface salinity along the Tropic of Cancer is around 36 parts per thousand (ppt) while at the equator it's around 35 parts per thousand. On the basis of their salinity levels, seas are categorized as follows:

- **Seas with salinity levels below the normal:** They have a low salinity due to the influx of fresh water. They include the Arctic Ocean, Southern Ocean, Bering Sea, Sea of Japan, Baltic Sea etc. Their surface salinity can be as low as 21 ppt.

- **Seas with normal salinity levels**: They have salinity in the range of 35 to 36 ppt. For example the Caribbean Sea, Gulf of Mexico, Gulf of California, Yellow Sea etc.

- **Seas with salinity levels above the normal:** They have higher levels of salinity because of their location in regions with higher temperatures leading to greater evaporation. For example the Red Sea (39 - 41 ppt), Persian Gulf (38 ppt), Mediterranean Sea (37 - 39 ppt) etc.

b. Vertical Distribution of Salinity

There is no definite trend in the variation of salinity with depth. Instances of increase, as well as a decrease in salinity levels, have been found with increasing depth.

Notes

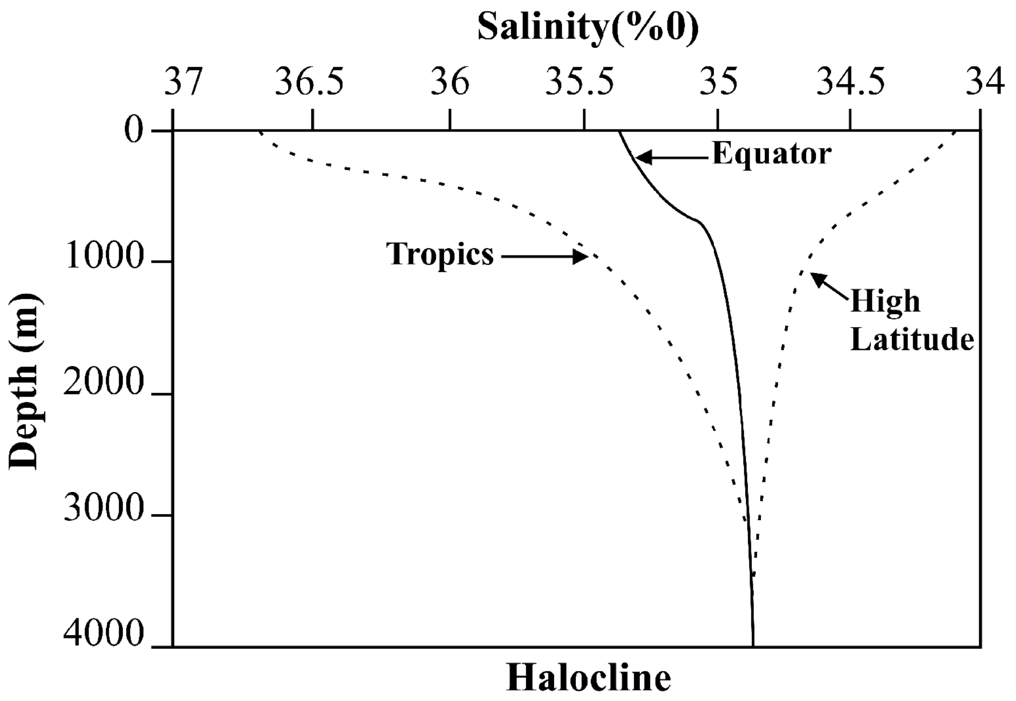


Fig. 5.6 Distribution of Salinity

From the above graph, it can be observed that,

- Salinity decreases with increasing depth at the equator as well as near the tropics.
- At higher latitudes, salinity is found to increase with increasing depth.

Salt Budget

Salt budget is commonly known as the salt cycle. It involves all the processes through which salt moves from the ocean into the lithosphere, to a certain extent into the atmosphere, and back into the oceans.

- The salinity level of ocean water is increased due to the mineral deposition taken from moving water, including groundwater. Minerals leach from the rocks through the process of surface erosion. The water with minerals joins the rivers and streams which finally reach the oceans. These minerals add to the salinity levels of the ocean waters.
- Some of the salts in the ocean waters accumulate at the ocean bottom through the process of sedimentation turning into mineralized rocks. Over a period of millions of years, some of these rocks get raised above the ocean surface due to plate tectonics, or due to volcanic activity. This brings the salt back to the lithosphere in the form of minerals.
- Salt from the oceans also gets sprayed into the atmosphere due to the action of wind. This salt returns to the lithosphere mixed with precipitation.

- Salt cycle operates over a very long period of time.

Every year, around 3 billion tons of salt gets added to the oceans from the land. A tiny fraction of this salt is extracted by humans for daily consumption.

INTEXT QUESTIONS 5.4

1. What are the determinants of salinity of the ocean?
2. How ocean currents determine the salinity of ocean?
3. What is the relationship between salinity and depth at higher altitudes?

5.6 OCEAN MOVEMENT

The ocean water is very dynamic. There is always some sought of movements happening inside the ocean water due to various physical characteristics such as salinity, temperature etc. and also some of the external factors like sun and moon influence those movements. There are three types of ocean movements-ocean waves tides and ocean currents.

a. Ocean Wave

Ocean waves are formed as wind blows across the surface of the ocean, creating small ripples, which eventually become waves with increasing time and distance.

The ocean is never still. Whether observing from the beach or a boat, we expect to see waves on the horizon. Waves are created by energy passing through water, causing it to move in a circular motion. Waves transmit energy, across the ocean and if not obstructed by anything, they have the potential to travel across an entire ocean basin.

The most common cause of waves is wind. Surface waves, are created by the friction between wind and surface water. As wind blows across the surface of the ocean or a lake, the continual disturbance creates a wave crest.

Severe weather condition like hurricane can also develop waves. The strong winds and pressure from this type of severe storm causes storm surge due to which a series of long waves are created far from shore in deeper water and intensify as they move closer to land.

Underwater disturbances also cause hazardous waves. It displaces large amounts of water quickly such as earthquakes, landslides, or volcanic eruptions. These very long waves are called tsunamis. Storm surge and tsunamis are not the types of waves. The gravitational pull of the sun and moon on the earth also causes waves. These waves are tides or, in other words, tidal waves.

b. Tides

The periodical rise and fall of the water level in oceans and sea, once or twice a day, due to the gravitational pull of the sun and the moon, is called a tide. The study of tides is very complex, spatially and temporally, as it has great variations in frequency, magnitude and height. Three major forces that causes an occurrence of tides are as follows:

1. Moon's gravitational pull
2. Sun's gravitational pull
3. Centrifugal force which acts opposite to gravitational pull of the earth.

Tides occur due to an imbalance between the various forces acting on the ocean water at a point of time. The tide-generating force is the difference between these two forces; i.e. the gravitational attraction due to the mass of the moon and the centrifugal force due to rotation of the earth.

Mechanism of Tides

- When the two forces are not in balance, it gives rise to the tide-generating force. The side of the Earth which is closest to the moon has the strongest gravitational pull towards the moon while water on the other side of the Earth experiences a weaker gravitational pull.
- The moon's gravitational force has a greater effect than the sun's gravitational force due to the relative distance of moon and sun respectively. The tide-generating force is proportional to the product of the mass of the two bodies but also inversely proportional to the square of the distance between them.

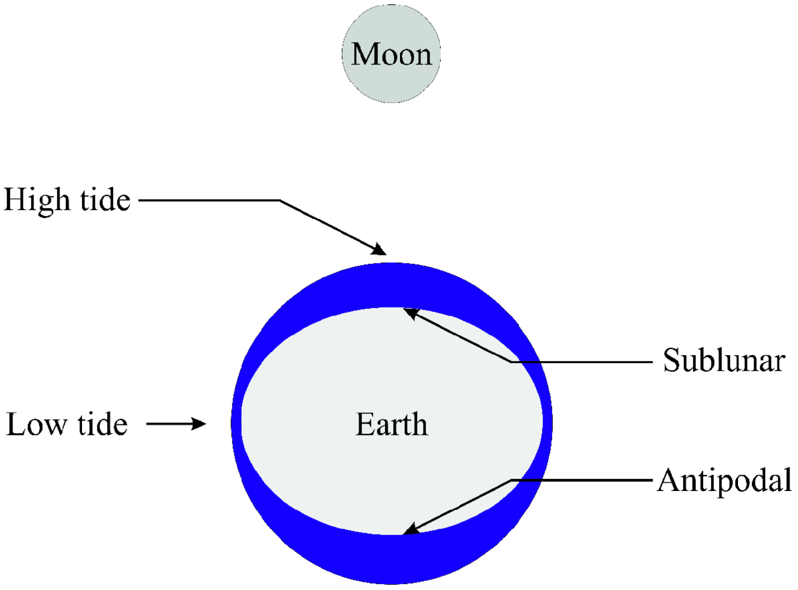


Fig. 5.7 Tide

Notes

Other Factors Controlling Tides

- Uneven distribution of water over the globe.
- Irregularities in the configuration of the oceans.
- When the tide is channeled into bays and estuaries they are called tidal currents.

Types of Tides

Types of tides is based on-

- Frequency
- The position of the earth, moon, and sun
- The time period between high tide and low tide
- Magnitude

i. Based on frequency

- **Semi-diurnal Tide**: This is the most common tidal pattern, featuring two high tides and two low tides each day.
- **Diurnal Tides**: Only one high tide and one low tide each day. The successive high and low tides are approximate of the same height.
- **Mixed Tide**: Tides having variations in heights are known as mixed tides. They generally occur along the west coast of North America and also in the Pacific Ocean.

ii. Based on sun, moon and earth's positions

- **Spring Tides**: When the position of the sun, the moon, and the earth are aligned in such a way that it forms a straight line, the height of the tide will be higher than normal. These are called as spring tides. It occurs twice in a month-one on the full moon and the other on the new moon.
- **Neap Tides**: After seven days of spring tides the sun and the moon form a 90 degree angle between each other. The resultant force of gravitation gives rise to a tide of very low magnitude which is termed as the neap tide. It also occurs twice in a month.

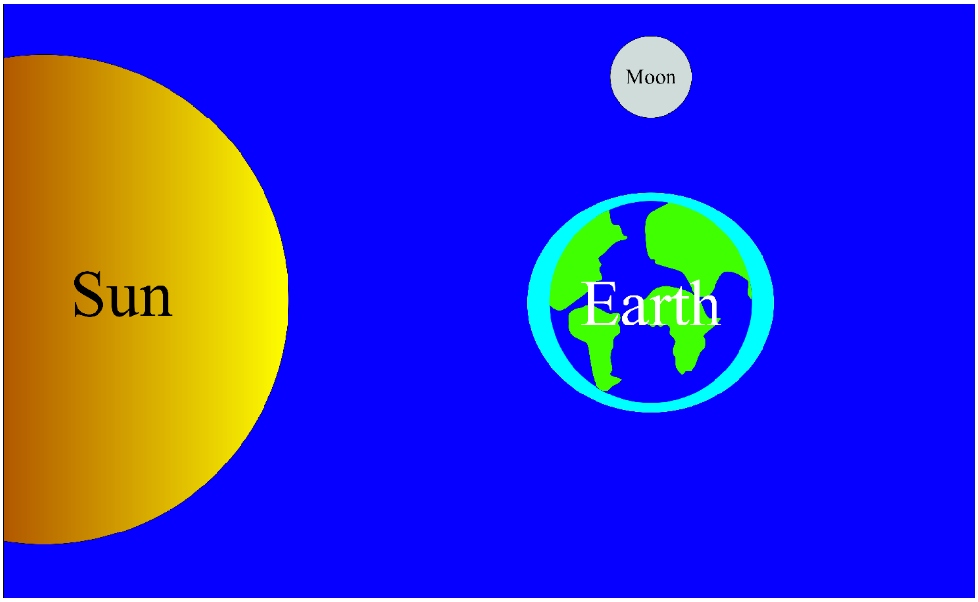


Fig. 5.8 Spring and Neap Tide

iii. Based on magnitude

- **Perigee**: When the moon's orbit is closest to the earth, it is called as perigee. During this period, unusual heights of high and low tide occur.
- **Apogee**: When the moon's orbit is farthest from the earth, it is called as apogee. Tidal ranges will be much less than average height during this period.
- **Perihelion**: It is the position where the earth is closest to the sun (around January 3rd). Unusually high and low tides occur at this time.
- **Aphelion**: It is the position where the earth is farthest from the sun (around July 4th). Tidal ranges will be much less than the average height during this period.

The time period between high tide and low tide

The time between the high tide and low tide, when the water level is falling is called the ebb. The time between the low tide and high tide, when the tide is rising, is called the flow.

Importance of Tides

- Tides help in navigation. Water level rises during high tide. Large ships can enter or leave harbour safely. Diamond Harbour in West Bengal and Kandla port in Gujarat are examples of such ports.
- Tides help the ships to travel up the mouth of the river in case of river ports. High tide increases the volume of water at the river ports to a high volume so that large ships can sail in safely and use a retreating tide to leave the port. Hooghly (Kolkata), London and New York are examples of some of the important river ports of the world.

Notes

- Tides help in removal of silt from river mouth. Rivers carry down a lot of soil and sand. Tides wash away these deposits and help to keep the mouth of the river clear.
- Salt water freezes at a temperature that is low than that of fresh water. In cold regions whereas the rivers are frozen in winter, the warmer seawater rushes into the harbours to keep it free from freezing.
- Tides are largely being harnessed to produce electricity as a renewable source of energy (Tidal energy).
- Tides bring in huge volumes of fish and these areas serve as fishing zones for fishermen without venturing too deep into the sea.

C. Ocean Currents

The ocean currents are the large masses of surface water that circulate in regular patterns around the oceans. Ocean currents can be classified into warm currents and cold currents depending upon their temperature.

i. **Warm currents -** Warm currents flow from equatorial regions towards the Polar Regions and hence have a higher surface temperature. These currents flow in the clockwise direction in the northern hemisphere and in the anti-clockwise direction in the southern hemisphere.

ii. **Cold currents -** Cold currents flow from Polar Regions towards the equator and have a lower surface temperature. Cold ocean currents flow in the anti-clockwise direction in the northern hemisphere and in the clockwise direction in the southern hemisphere.

Factors responsible for Ocean Currents

The following factors are responsible for ocean currents:

i. **The Planetary winds-** The Earth's atmosphere is divided into permanent pressure belts - The Equatorial low-pressure belt, The Sub-tropical high-pressure belt, Sub-polar low-pressure belt and Polar high-pressure belts. The planetary winds are permanent winds that blow from one pressure belt to the other.

The Planetary winds influence flow of ocean currents. Evidence of prevailing winds on the flow of ocean currents can be seen in the North Indian Ocean where there is a change in the direction of ocean currents with a change in direction of the monsoon winds. The oceanic circulation pattern corresponds to the earth s atmospheric circulation pattern.

ii. **Temperature-** The energy from Sun reach at the equator more than the poles is the reason behind the difference in the temperature of ocean water. As the temperature gets higher the ocean water gets heated up and expands at the equator. Sun energy makes the warm water lighter and it rises while at the poles, cold water is denser and sinks. Warm water from the equator slowly moves along the surface towards the poles, while the cold water from the poles slowly creeps along the bottom of the sea towards the equator.

iii. **Salinity-**The density of water also depends on its salinity and the salinity of water varies from place to place. Waters of low salinity flow on the surface of waters of high salinity while waters of high salinity flow at the bottom.

iv. **The earth's rotation and Coriolis force-**The earth's rotation deflects moving objects to the right and ocean currents are no exception. Under the action of Coriolis force, the movement of ocean currents in the northern hemisphere is in the clockwise and in the southern hemisphere it is in the anti-clockwise direction. Hence it can be said that ocean currents obey Ferrel's law.

v. **Obstruction due to land-** A land mass obstructs the direction of flow of ocean current and divides the ocean current which in turns flow in a different direction. Example: The south equatorial current in the Atlantic Ocean is obstructed by South American continent and the South equatorial current divides to create the Brazilian current which flows in the south Atlantic Ocean.

Distribution of Ocean Currents

a. **Currents in the Pacific Ocean;**

- **Warm Currents** are; North Equatorial Current, South Equatorial Current, Counter Equatorial Current, Kuroshio System, East Australia Current, and North Pacific Drift.
- **Cold Currents** are; Oyashio Current, California Current, and Peruvian or Humboldt Current.

Currents in the Atlantic Ocean

- **Warm currents** are; North Equatorial Current, South Equatorial Current, Equatorial Counter Current, Gulf Stream, Florida Current, and Brazilian Current.
- **Cold Currents** are; Canaries Current, Labrador Current, Falkland Current, South Atlantic Drift, and Benguela Current.

The domain of the water on the earth

Notes

Currents in the Indian Ocean

- **Drifts** are; The North East Monsoon Drift, and The South West Monsoon Drift.
- **Warm currents** are; North Equatorial Current, South Equatorial Current, Mozambique Current, Madagascar Current, and Agulhas Current.
- **Cold Currents** are; Somali Current, and West Australian Current.

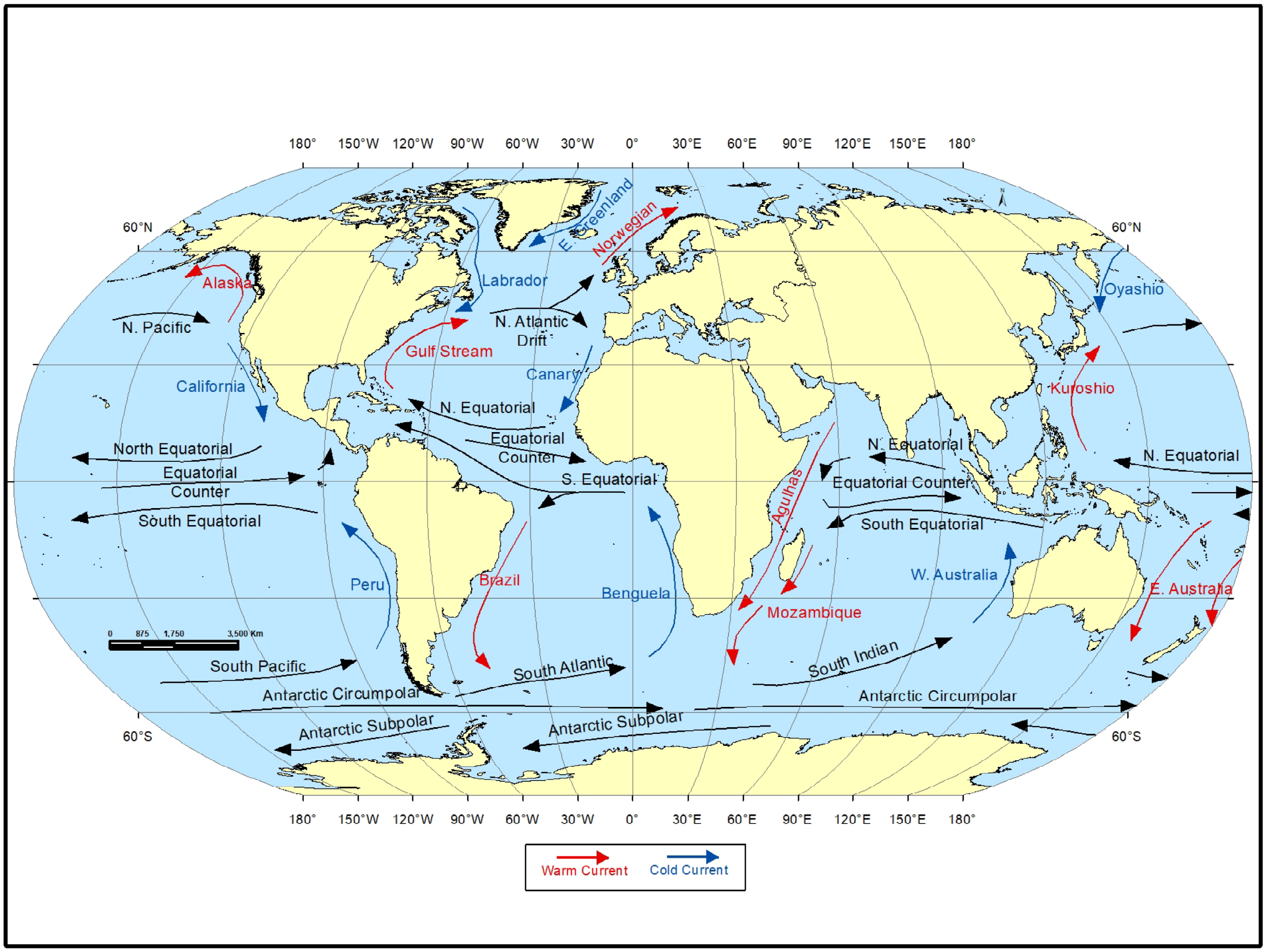


Fig. 5.9: Ocean Currents

INTEXT QUESTIONS 5.5

1. What is a Diurnal tide?
2. Define Aphelion.
3. Name the position when earth is closest to the sun thus causing unusually high and low tide.

4. Name the drifts of Indian Ocean currents.

5. Name the warm currents of Atlantic Ocean.

6. Name the cold currents of Pacific Ocean.

WHAT YOU HAVE LEARNT

- ***Hydrological Cycle***: Elements of Hydrological Cycle are; Evaporation, Condensation, Precipitation, Evapotranspiration, Runoff and Infiltration.
- ***Groundwater Hydrology*****:** Groundwater Hydrology is based on the porosity of Soil, Permeability of Soil, and Aquifers.
- ***Ocean Relief:*** Major Relief features are; Continental Shelf, Continental Slope, Continental Rise and Deep Sea Plain or Abyssal Plain.
- ***Ocean Temperature:*** Major determinants of distribution of temperature are; Latitude, Prevailing winds, Unequal distribution of Land and Water, Evaporation Rate, Density of Water and Ocean Currents.
- ***Ocean Salinity***: Major determinants of distribution of Salinity are; Evaporation, Temperature, Precipitation and Ocean Currents.
- ***Ocean Tides:*** Different types of tides based on position of Earth, Moon, and The Sun are; Spring Tides and Neap Tides
- ***Drifts of Indian Ocean currents:*** The North East Monsoon Drift, and The South West Monsoon Drift.
- ***Warm currents of Atlantic Ocean:*** North Equatorial Current, South Equatorial Current, Equatorial Counter Current, Gulf Stream , Florida Current, and Brazilian Current
- ***Cold currents of Pacific Ocean:*** Oyashio Current, California Current, and Peruvian or Humboldt Current.

TERMINAL QUESTIONS

1. What is hydrological cycle? Diagrammatically explain the process of hydrological cycle.

2. Describe the major relief features of ocean floor?

3. What are tides? Describe the mechanism of tide formation.

Notes

4. Explain the vertical and horizontal distribution of temperatures.
5. What are the determining factors of salinity?
6. Describe the various types of tides.

ANSWERS TO INTEXT QUESTIONS

5.1

1. Porosity is the measurement of the open space within the rocks. This space can be between grains or within cracks or cavities of the rock.
2. A water budget provides a ground for evaluating availability and sustainability of a water supply.
3. Evaporation, condensation, precipitation, interception, infiltration, percolation, transpiration, runoff, and storage (any two).
4. The underground layer of water-bearing permeable rock, rock fractures or unconsolidated materials is known as an aquifer. Groundwater can be extracted using water well. The study which is concerned with the study of the flow of aquifers is known as hydrogeology.

5.2

1. The continental slope is the connection between continental shelf and continental rise.
2. Ridges, Seamount, Trenches, Guyots, Coral reefs, Atolls.
3. The Continental Shelf , The Continental Slope , The Continental Rise ,The Deep Sea Plain or the Abyssal Plain
4. Trenches are relatively long, steep-sided, narrow basins. These areas are the deepest parts of the oceans.
5. Lakshadweep Islands.

5.3

1. Latitudes, Prevailing winds, Unequal distribution of land and water, Evaporation rule,density of water and ocean currents.
2. Direction of the prevailing winds such as the Trade Winds, Westerly's etc., determines the surface temperature of ocean waters at a point

3. 12 degrees Celsius.

4. Surface zone or mixed zone, Thermocline and Deep zone.

5. It lies between 100 meters and 1000 meters. It contains about 18 percent of the total volume of water in the ocean.

5.4

1. Evaporation, Temperature, Precipitation, Ocean Currents, The influx of fresh water.

2. Ocean currents plays crucial role in the spatial distribution of dissolved salts in ocean waters.

3. At higher latitudes, salinity is found to increase with increasing depth.

5.5

1. Diurnal tide is tide which takes place 0nly one high tide and one low tide each day. The successive high and low tides are approximate of the same height.

2. It is the position where the earth is farthest from the sun (around July 4th). Tidal ranges will be much less than the average height during this period.

3. Perihelion.

4. The North East Monsoon Drift, and The South West Monsoon Drift.

5. North Equatorial Current, South Equatorial Current, Equatorial Counter Current, Gulf Stream , Florida Current, and Brazilian Current

6. Oyashio Current, California Current, and Peruvian or Humboldt Current.

MODULE - 4

Dynamics of Atmosphere

6. Structure and Composition; Insolation
7. Atmospheric Pressure and Winds
8. Humidity and Precipitation
9. Climate and Climate Change

6

STRUCTURE AND COMPOSITION; INSOLATION

In the earlier lesson, you got familiar with the significance of oceans and its variation in the temperature. As you know, life on earth originated in the oceans. In other words, Earth is the only known planet in the universe where life exists due to the presence of air and water. Both have noteworthy effects on our survival as they have different characteristics. For example, we can see and touch water but we can neither see nor touch air; we can only feel the movement of air. In this lesson, you will learn about the structure and composition of atmosphere, insolation, distribution of temperature and heat budget.

OUTCOMES

After studying this lesson, learner:

- identifies the layers of atmosphere;
- describes the composition of atmosphere;
- explains the factors influencing insolation and its horizontal distribution and
- describes the heat budget with the help of a diagram.

6.1 ATMOSPHERE

Before discussing composition and structure of the atmosphere, let us know more about the atmosphere in general. We know that life is only possible on the Earth's surface. The main reason for this is the presence of air. Without any horizontal movement we can't feel the presence of air. The earth is surrounded by a gaseous envelope which acts like an air blanket on the earth 's surface. It is attached due to the gravitational force of the earth. This is known as the atmosphere. Earth is a green planet only due to its atmosphere, without this existence of water bodies, clouds and sound are not possible.

Atmosphere protects the earth from harmful solar energy such as ultraviolet radiation. It is a very important part of our fragile earth system which controls our various human activities by different processes. Earth receives solar energy through the atmosphere. The climatic phenomena such as temperature, air pressure, winds, moisture, clouds, precipitation, fog, frost etc. are occurring in lower atmosphere. Atmosphere plays a fundamental role in the distribution or redistribution of energy over the planet earth through energy exchange to each other.

In recent years, the changing environment of the earth's surface has contributed to changes in atmospheric composition in the form of undesirable concentration of carbon dioxide, high pollution levels, ozone depletion and global warming. Among all, global warming is a major cause of concern. However, all these problems are also a matter of atmospheric dynamics.

Among all of them global warming is major of concern in present scenario. Global warming is the result of greenhouse effect. It means the gradual increase in world-wide atmospheric warming due to accumulation of heat in lower atmosphere through the greenhouse gases like carbon dioxide (CO_2), Methene (CH_4), Chlorofluorocarbons (CFCs), Nitrous Oxide (N_2O), Ozone (O_3), water vapour. These phenomena are changing the composition of the atmosphere. We can better understand atmosphere, by knowing its composition.

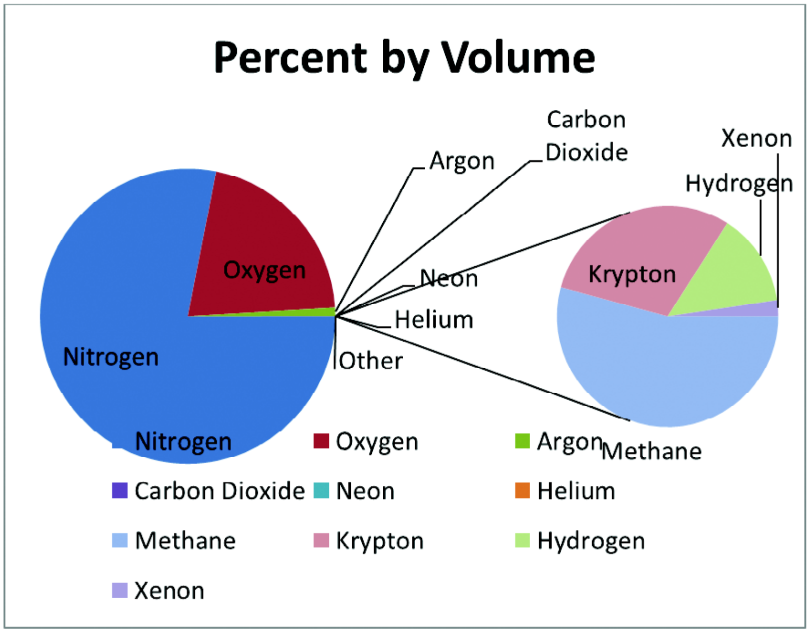
6.2 COMPOSITION OF ATMOSPHERE

As we know, the atmosphere is made up of various gases, dust particles and water vapour. These are neither static nor spread uniformly in the atmosphere. We can find variation in their distribution according to altitude, latitude and seasons. The characteristics of three basic constituents' namely, gases, water vapour and dust particles are as follows:

a. Gases of atmosphere

Gases of atmosphere are, broadly, divided into two groups i.e. permanent and variable gases. Nitrogen, Oxygen, Argon, Neon, Helium, Hydrogen, and Xenon are permanent gases and Carbon dioxide, Methane, Nitrous oxide, Ozone and Chlorofluorocarbons (CFCs) are variable gases. We can see their amount of concentration by percentages in the given figure. It shows Nitrogen and Oxygen are found in large amounts.

Notes



Gases	Percent by Volume
Nitrogen	78.08
Oxygen	20.95
Argon	0.93
Carbon Dioxide	0.0314
Neon	0.0018
Helium	0.0005
Methane	0.0002
Krypton	0.00011
Hydrogen	0.00006
Xenon	0.000009

Fig. 6.1 Composition of atmosphere

i. **Nitrogen:** Nitrogen is very important for all life forms in the biosphere because it is an essential part of amino acids which makes up proteins. It helps in controlling combustion by diluting oxygen and also indirectly helps in oxidation.

ii. **Oxygen:** Oxygen is a very active gas which combines with the majority of elements in the biosphere. Through the process of photosynthesis and respiration, it is exchanged between atmosphere and living organisms.

iii. **Carbon Dioxide:** The role of this gas is very important in atmospheric processes because of its ability to absorb radiant heat. It is a vital greenhouse gas that taps earth's outgoing radiation and is causing global warming. Its percentage is increasing in the atmosphere due to increasing burning of fossil fuels such as wood, coal, natural gas, gasoline and oil etc.

iv. **Ozone:** It is unevenly distributed and lies in between 20 km to 25 km of altitude. Ozone has a protective role in the atmosphere as it's essential for maintaining habitability of earth. It blocks the harmful ultraviolet radiation from the sun.

v. **Methane:** Methane is a second most abundant greenhouse gas which is emitted from both anthropogenic (landfills, agricultural activities, coal mining, stationary and mobile combustion) and natural sources. Methane absorbs earth radiation quite efficiently. Its presence in the atmosphere affects the temperature and climate system of earth.

b. Water Vapour

Water vapour is water in gaseous instead of liquid form. It is also the most important gas in the atmosphere. Some important facts about water vapour are as follows:

- Hydrosphere is the source of atmospheric water vapour.
- It changes their state from vapours (gas) into liquid (water) and liquid into solid (ice).
- Amount of water vapour varies in different regions. Maximum amount of water vapour present in the atmosphere is up to 4%.
- All forms of precipitation whether in liquid or solid are possible only by conversion of water vapour into the other forms.
- It also absorbs long-wave terrestrial radiation. Water vapour plays an important role in heat energy balance.

c. Dust Particles

Dust particles are made of fine particles of solid matter. It is found in the atmosphere. Its main significance is that they help in the formation of clouds, which in turn is important for precipitation and rainfall on earth.

INTEXT QUESTIONS 6.2

Write True against the correct statement and False against the incorrect statement:

i. Carbon dioxide is responsible for global warming.

ii. Nitrogen is very important for making proteins which is an essential part of amino acid.

iii. Atmospheric dust particles are mainly found in the upper part of the atmosphere.

iv. Methane is a permanent gas.

6.3 STRUCTURE OF THE ATMOSPHERE

Atmosphere is multi-layer gases and it is a component of the Earth-environment system. The atmosphere can be divided into various vertical layers. These layers are distinguished from one another by temperature, chemical composition and related phenomena.

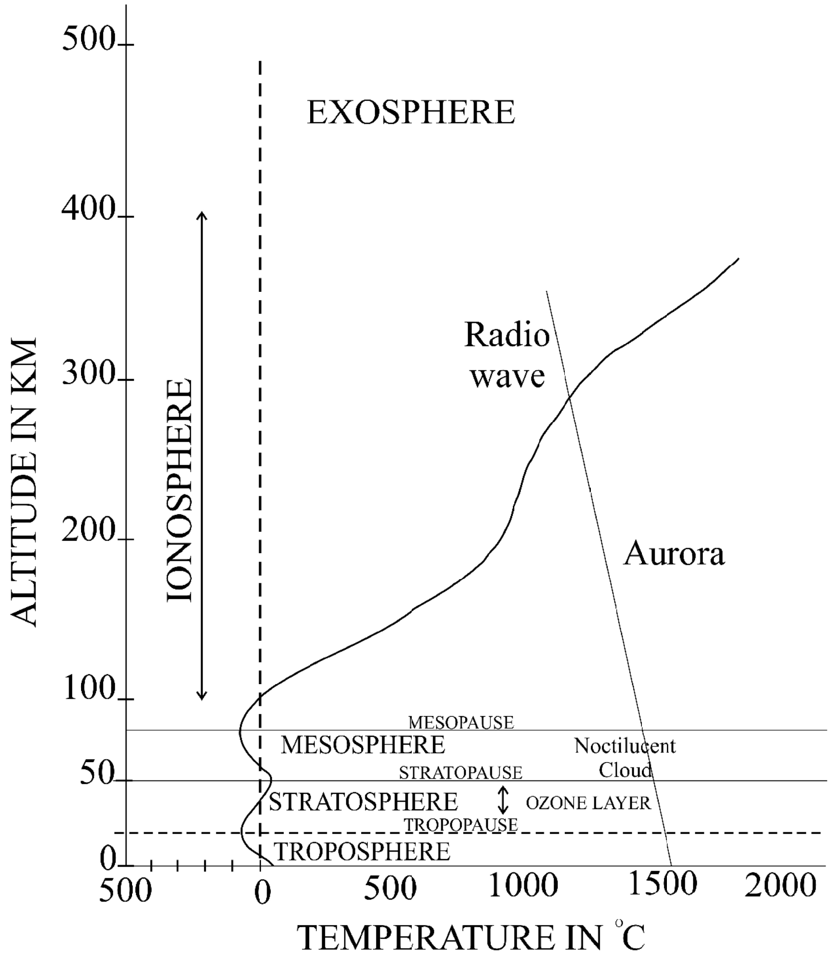


Fig. 6.2 Vertical Layer of Atmosphere

i. Troposphere

- The Troposphere is the first and lowermost layer of the atmosphere. This layer contains about 75% of gaseous mass along with the concentration of pollutants.
- The average height of this layer is around 12 kms., which varies with latitude. The height of the troposphere is not constant as it is 16 kms. on the equator, whereas 8 kms. on the poles.
- On the equator, height of this layer is determined by the presence of conventional hot currents.
- The lowest temperature is observed in this layer with increasing height. Moreover, all types of climatic and weather phenomena take place within the troposphere.
- A gradual decrease in the temperature with height is 6.5°C per thousand metres. This phenomenon is known as "Normal lapse rate". As the gradual decrease in temperature stops, tropopause starts.

ii. Stratosphere

- The stratosphere extends from tropopause to a height of 50 kms.
- Thermal conditions of the lower part of the stratosphere are stable due to non-existence of dust particles, water vapours and conventional current. It is known as an isothermal zone.
- This layer is considered ideal for flying aeroplanes because weather events do not take place. The Stratosphere covers about 24 % of the total air mass.
- As height increases, the temperature in the stratosphere increases due to the presence of ozone gas in the upper part of the layer.
- Without the Ozone layers, all living things could not exist on earth's surface. It protects us from the harmful effects of ultraviolet solar radiation.

? DO YOU KNOW?

Vertical layer of lower stratosphere is known as **Isothermal zone** because the temperature remains constant with increasing altitude.

iii. Mesosphere

- Mesosphere is the third layer of the atmosphere which extends up to 80 kms.
- The temperature in the mesosphere continuously decreases with increasing height. The layer records the lowest temperature in the atmosphere i.e. -100° Celsius.
- Meteors occur in the mesosphere and "Noctilucent" clouds are formed by the process of condensation in association with meteoric dusts.

iv. Ionosphere

- The fourth layer, the ionosphere , is located above the mesosphere up to the height of 400 kms.
- Due to the high concentration of ions particles, this layer is known as the ionosphere. Temperature rises with increasing height in this layer.
- The Ionosphere plays a significant role in radio communications. From this layer, radio waves are reflected back on the earth and due to this radio broadcasting has become possible.
- The phenomenon known as "Aurora" has also been observed in this layer.

v. Exosphere

- This is the last and uppermost layer of the atmosphere.
- Exosphere is located above 400 kms of height after the ionosphere.
- Gases are very sparse in this layer because of the lack of gravitational forces.
- Hydrogen and Helium gases are predominant in this layer. They are very light in nature. Therefore, the density of this layer is very low.

INTEXT QUESTIONS 6.3

i. Name the layer which is related to "Normal lapse rate"

ii. Which gas protects us from ultraviolet solar radiation and where is it located?

iii. What is the importance of the ionosphere?

iv. Name the Layer where density is very low.

6.4 INSOLATION

The Sun is the primary source of energy, which has a surface temperature of more than 6000° Celsius. The radiant energy from the sun comes in the form of short-wave radiation. Incoming solar radiation (IN+SOL+ATION) is known as insolation. Therefore, Insolation has been defined as the energy received from the sun in the form of short-wave radiation.

A. Factors influencing Insolation

Amount of insolation is not uniform and varies with time and place. The tropical region receives more insolation than the polar region. Similarly, seasonal variation has also been observed, such as the amount of insolation is greater in summer than winter.

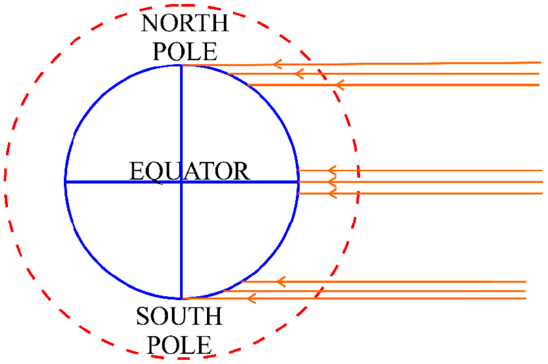
i. The Angle of Incidence

The amount of insolation on the earth surface depends on the angle of sun's rays which formed at the time of sun striking on earth surface. Every place on earth has a different angle of the sun's rays. As some places receive vertical angle and some receive oblique angle of the sun's rays. It is known as angle of incidence. This controls the amount of insolation in two ways: -

- When the sun rays are vertical, they are concentrated on a smaller area and give maximum insolation. On the contrary, the place where the angle of sun's rays is oblique, heats up a large area and receives less amount of insolation.

On the equator, the sun is always vertically overhead, as we move towards poles, the angle of incidence becomes oblique gradually. Therefore, the amount of insolation is greater on the equator and continues to decrease towards poles.

- Before reaching the earth surface, rays have to pass through the atmosphere. We know, rays with oblique angles have to travel a larger area. Therefore, much of their heat is reflected and absorbed by water vapours, clouds and dust particles. This is the reason why poles receive less amount of insolation. On the other hand, the Equator receives a high amount of insolation, because the distance between earth and atmosphere is less.



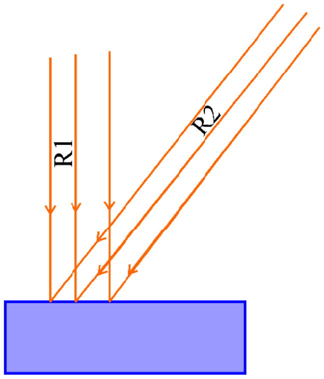


Fig. 6.3 (a) Angle of sunlight and altitude (b) Vertical (R1) and Oblique (R2) Sunrays

ii Duration / Length of day

The amount of insolation depends on the length of the day because it is received only in the daytime. Therefore, as the length of day is longer, the amount of insolation will be maximum. Length of day or duration of day time also varies from place to place and seasons to season. Only at equator, day and night is 12 hours, throughout the year. As we move towards poles from the equator, we can observe the variance between day and night as per the latitudes.

Table 6.1 Maximum length of day at different latitudes

Latitude	0°	17°	41°	49°	63°	66.5°	67°21'	90°
Length of the day (hours)	12	13	15	16	20	24	1 month	6 months

iii. Transparency of atmosphere

The amount of insolation also depends on the transparency of the atmosphere. The transparency of the atmosphere may also control the amount of insolation. It is

determined by cloud cover, water vapours and dust particles. As an increase in the quantity, especially clouds and dust particles, they reflect the insolation. Besides this, insolation is also absorbed by water vapour in the atmosphere. For example, thick clouds hinder the insolation to reach while clear sky condition helps in reaching insolation on earth surface.

B. Way of Energy Transfer

We already know, sun is the only source of energy and we get it directly as insolation. Besides that, there are some ways by which energy can be transferred from one place to another place as follows:

i. **Radiation:** Radiation is a very important process in the atmosphere. In radiation, heat transfers through space by waves, it is called electromagnetic waves. The Process of radiation does not require any medium to transfer the heat. It can pass through the atmosphere without the aid of the air molecules and also move even in a vacuum. In other words, radiation is the way by which solar energy reaches the earth in short waves and heat is radiated from the earth in long waves. Temperature and wavelength are inversely related. Hotter the object shorter is the length of the wave and vice versa.

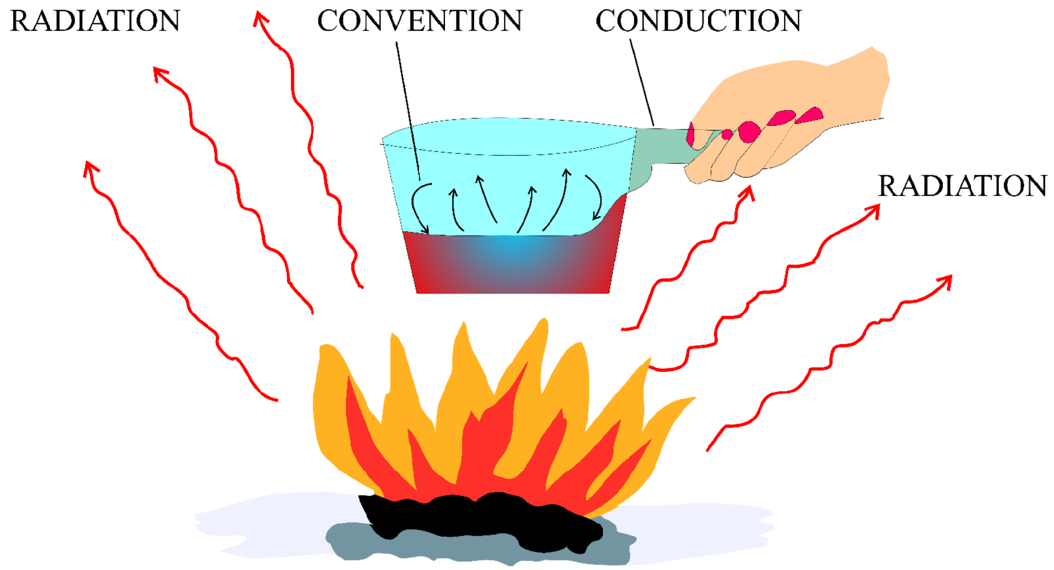


Fig: 6.4 Ways of energy transfer within the Earth atmosphere

ii. **Conduction:** In the process of conduction, heat transfers from one molecule to another molecule within a substance. In this process, heat energy flows from the warmer object to the cooler object. This process continues till the temperature of both objects become equal, or the contact is broken. When material and objects can easily pass energy from one place to another, it may be called the lower good

conductor of conduction. Air is a bad conductor of conduction. By this process, the atmosphere is heated in contact with the surface heat.

iii. **Convection:** In this process, heat has been transferred by the mass movement of fluids like water and air. It is a very important process of heating the atmosphere. The conventional process in the atmosphere is associated with the cyclic movement of heat transfer from the lower layer to the upper layer. In cyclic movement, atmosphere heats a higher part of the atmosphere

When incoming solar radiation strikes with atmospheric gases, dust particles and air molecules, some amount of energy is lost through various processes, which are as follows:

- **Scattering:** During the process of incoming solar radiation, sun rays strike at air molecules and dust particles. The sunlight deflected in different directions (up, down, and sides); this is called scattering. It depends on the size of particles and wavelength of light. For example, blue light with shorter wavelength scatters more easily than red light. This is the reason behind the blue colour of our sky.

- **Reflection:** When some sunlight is striking by air molecules and clouds that insolation is reflected to space. For example, clouds are the most important reflector which reflectivity depending upon the thickness of clouds. The amount of reflected sunlight is known as albedo.

- **Absorption:** In this process, radiation is retained by a substance and converted to heat energy. Mainly heat has been absorbed by gases, water vapour and dust particles in the atmosphere. Oxygen, ozone, carbon dioxide and water vapour are known to be good absorbers. For example, ultraviolet radiation is absorbed by oxygen and ozone at the stratosphere.

INTEXT QUESTIONS 6.4

i. Define insolation.

ii. What are the factors influencing the amount of insolation?

iii. By which process energy transfers from sun to earth?

iv. In which place, hours of the day and night are equal throughout the year.

Notes

6.5 HEAT BUDGET

Earth not only received solar energy but also reradiated the energy. Energy released from the earth surface is in the form of longwave radiation.This is known as terrestrial radiation. Earth receives continued energy from the sun but earth maintains average temperature. Incoming energy from sun to earth and outgoing energy from earth to sun is going on simultaneously. This flow of energy is a complex system; this involves radiation, storage and transport of heat.

As we already know, water plays a powerful controller in global heat supply and energy exchange. Water has the capacity to absorb or release heat between the atmosphere - ocean - continent systems.

At global level, heat received and energy absorbed by our planet is matched by planetary output of terrestrial energy transferred into outer space. The energy exchange between earth and atmosphere absorbs energy from the sun as well as from each other a delicate balance is maintained. These gains and losses of heat through incoming and outgoing radiation are known as **'Heat Budget'**

The 100 units of energy from the sun reaches the top of earth's atmosphere. Out of the total 35% of insolation are reflected through clouds (27%) and scattered (6%) out to space. It has no role in heating the earth. This amount of reflected energy is known as **'Albedo'**. From the remaining 65%, 14% of energy is absorbed by gases and water vapour in the atmosphere. The Rest 51% (65-14=51) of energy is received as through the direct radiation (34%) and by diffuse daylight (17%) on earth's surface.

On the other hand, earth warms the layers of air above by direct contact or conductions and transmission of heat by upward movement of air through convection currents. Out of 51% of total energy received by the earth's surface is sent back to the atmosphere (34%) and in space (17%) through terrestrial radiation.

Total budget of the atmosphere is 48% of which 14% is received through absorption of solar radiation. Others (48-14=34) received by various ways like evaporation (19%) convection (9%) or turbulence and absorption 6% by atmosphere (19+9+6=34) of terrestrial radiation.

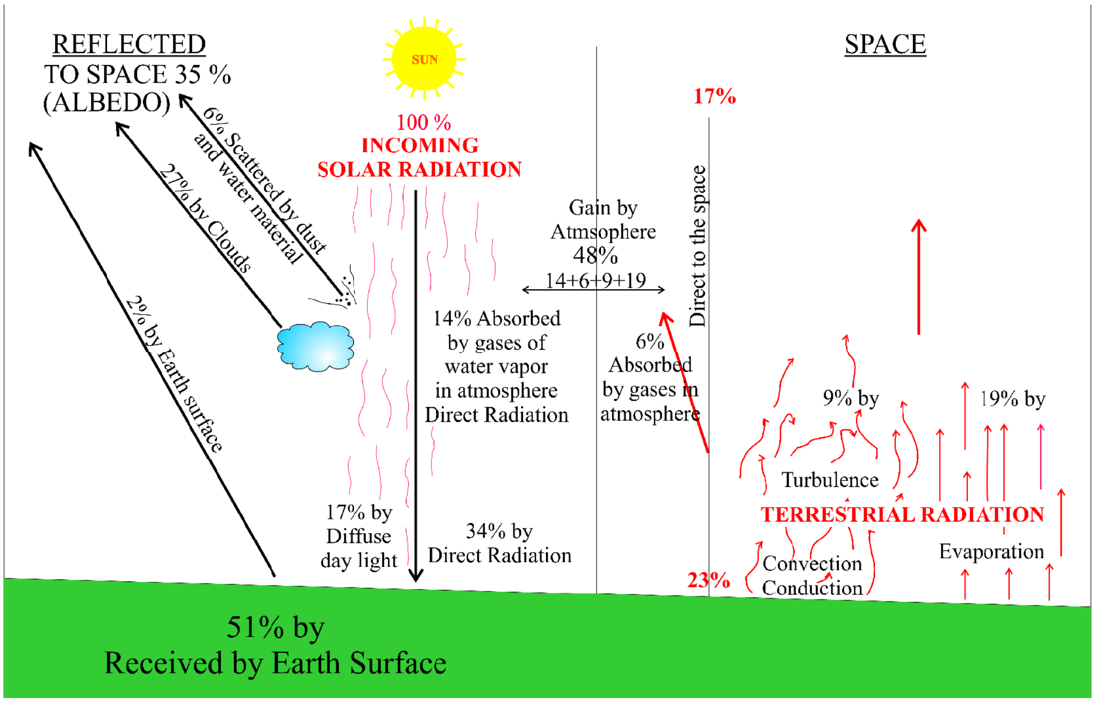


Fig 6.5 The earth's heat budget

i. Heat Transfer

On the basis of the above discussion, net annual radiation for the globe is zero. In some places energy is coming faster than it is going out. This is known as gain or energy surplus and loss or energy deficit. High intensity of insolation at low latitude, it gradually decreases towards the poles. At the global level, the area between 40 north latitude to 40-degree south latitude is an energy surplus region. Poleward from the 40 north and south latitude is a two deficit set of energy regions. Therefore, the latitudinal balance of energy is not maintained by each latitude. To compensate for the deficit and surplus of energy, wind in the atmosphere and currents in the oceans exchange warm air and water towards poles and cold air and water towards the equator. By this process net latitudinal radiation for the entire globe is zero.

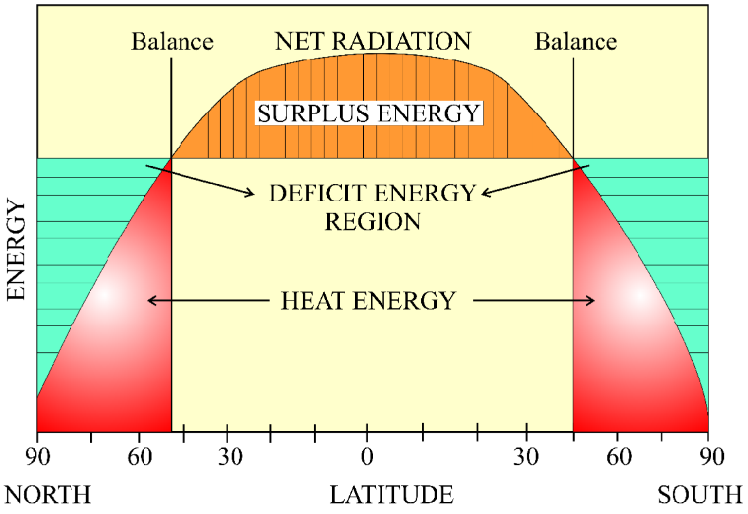


Fig 6.6 Average latitudinal distribution of radiation

INTEXT QUESTIONS 6.5

i. What do you mean by the term 'Albedo'?

ii. What is the Heat budget?

iii. Which amount of energy received by earth?

iv. What is the net annual radiation for the globe?

6.6 TEMPERATURE

Do you know, intensity of heat is known as temperature? It is measured by the degree of hotness of the heat energy available in the air and soil. Temperature only indicates how "hot" or "cold"an object or particle is. The temperature of air near the surface of the earth is warmer than the air above it. We know that the temperature decreases with height in the troposphere. But sometimes the temperature increase with height under special circumstances is called inversion of temperature. It may occur at close to land surface or it may also at upper atmosphere. Temperature inversion near the surface may occur under such conditions like long and clear winter nights, clear skies, calm air and snow-covered surface etc.

Temperature of any particular place is a result of several complex combinations of elements, which are directly and indirectly controlled by various factors. It, directly depends on the amount of insolation of a given place and distribution of temperature which indirectly determined by the several others elements of earth's surface such as winds, currents, water and land distribution etc.

a. Factors of temperature distribution

Among various factors regarding the amount of insolation received, Latitude is an important factor that controls spatial variations of temperature distribution on the earth's surface. Some others factors which determine temperature of place are as follows:

i. **Latitude:** The total amount of solar energy received varies as per different latitudes. It is intense in amount at the lower latitudes and gradually decreases towards higher latitudes. In the last section we have already understood that the vertical position of the sun's rays at the equator almost throughout the year, favours the high amount of isolations. Inclination of the sun's rays increases from equator (low latitude) to poles (high latitudes). Therefore, the angle of the sun rays is the prime reason for the variation in the amount of solar energy.

Notes

ii. **Altitude:** Height above the sea level (altitude) of any place also controls the temperature of a given place. Temperature decreases with height at the rate of 1 degree for 165 metres. It is known as normal lapse rate.

iii. **Cloudiness:** As we know, the amount of insolation is also determined by the sky conditions, especially cloudiness. Clouds reflect insolation to space and do not express high temperature. High temperature found in clear and cloudless sky.

iv. **Winds:** Winds are the most important changer of the place. Warm winds raise the temperature while cold winds cause a fall in temperature. Winds wherever they are blowing from their original place changes the temperature of that place as per their nature (hot or cold). For example, the hot wind of the Sahara Desert "Sirocco" blows towards Italy and raises the temperature.

v. **Nature of the Land Surface:** Land surface affects inversely towards amount of insolation as per their nature. For example , snow cover areas (bright and smooth) reflect the maximum amount of solar radiation and temperature remains low while dark colour surfaces (black soil region) absorb maximum solar radiation which helps in raising the temperature.

vi. **Distribution of Sea and Land:** Due to variations in the rate of heating and cooling of land and water experiences great variations in temperature of the same place. On the land temperature is higher during summer and day time. On the other hand, oceans have high temperatures in winter and during nights. The seasonal variations in temperature are the results of spatial variations.

vii. **Oceanic Currents:** Like wind, oceanic currents also influence the temperature of adjacent areas. An oceanic current moves from warm temperature areas to colder temperature areas and vice versa. Moving currents influence the temperature of their path by its original nature of current like warm or cold. The warm currents raise the temperature whereas cold currents lower the temperature of areas.

b. Horizontal Distribution of Temperature:

When we study temperature across latitudes is known as horizontal distribution. It is shown by the "isotherm" lines on the map. Isotherm (ISOS means equal and THERMS means temperature) line is an imaginary line which joins places having equal temperature. After a detailed study of isotherms, we can understand the temperature of a particular place. If we look at the global level, January is considered the coldest month while July is the hottest month of the year. Both the months represent seasonal extremes of temperature. Therefore, we should study these months separately.

(i) Horizontal Distribution of Temperature in January: In the month of January, Winter season in the northern hemisphere and summer season in the southern hemisphere. Its main reason is the position of the sun which is vertically overhead near the tropic of Capricorn. High temperature regions are in the southern hemisphere i.e. north-west Argentina, east-central Africa, Borneo and central Australia. We can see Isotherms of 30° Celsius passing through these regions.

In January, the landmass of the northern hemisphere is colder in comparison to ocean areas. In the northern hemisphere, the Northeastern part of Asia experiences low temperatures. Especially, the middle part of the continent shows a lower temperature than the oceans areas of the same latitude.

Due to large expanse of water exist in the southern hemisphere; isotherms lines are regular and widely spaced. On the other hand, in the northern hemisphere isotherms lines are irregular and closely spaced due to large expanse of land masses.

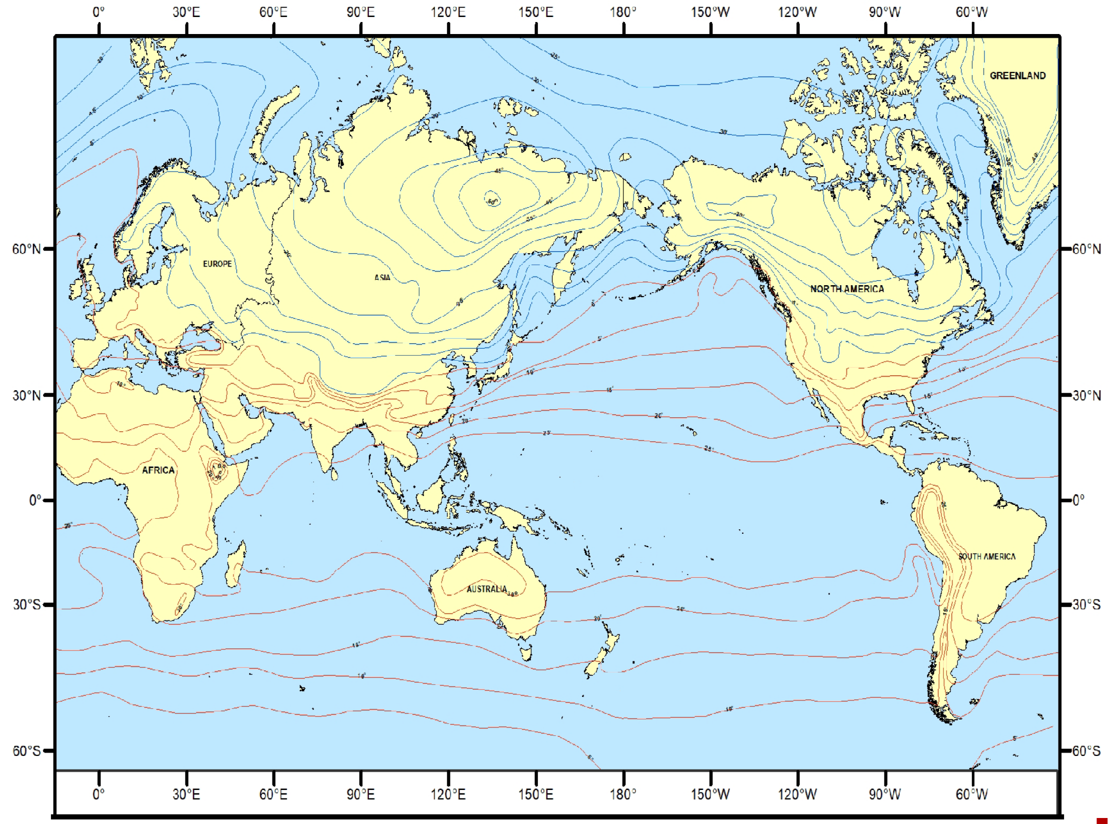


Fig. 6.7 Horizontal distribution of temperature in January

(ii) Horizontal Distribution of Temperature in July: As the sun position is vertically overhead near the tropic of cancer in the month of July. Therefore, the northern hemisphere experiences summer seasons. High temperature is experienced in the entire northern hemisphere and isotherms line of 30° Celsius located between 10°

Notes

north and 40° north latitudes places like south-eastern U.S.A, the Sahara, and Arabia, Iraq, Iran, Afghanistan, the Gobi Desert, Chani and Thar Desert of India have high temperatures. At the same time, the lowest temperature of 0° Celsius is also located in the northern hemisphere, especially in the central part of Greenland. The temperature of middle areas of the continents in the northern hemisphere is higher than oceans of the same latitude. Oceans areas have shown wider spacing isotherms lines than continents.

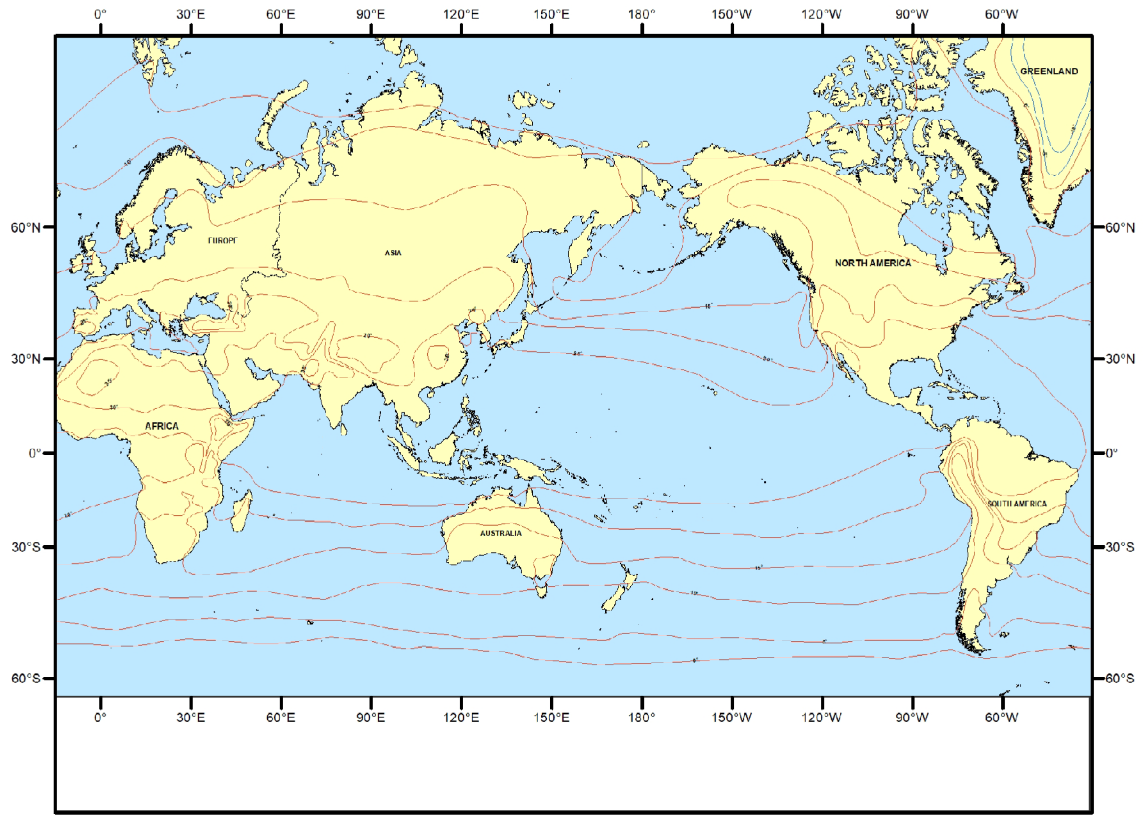


Fig. 6.8 Horizontal distribution of temperature in July

After the study of the isotherms line of January and July, we found lines change very little in position over the equator. This shows the feature of consistency of insolation throughout the year near the equator.

Apart from the horizontal distribution of temperature, vertical distribution of temperature is also important. Generally, temperature decreases with increasing height in the troposphere. It varies with height, latitude and seasons. Sometimes temperature increases with increasing altitude but the phenomenon has been characterised temporarily and locally.

INTEXT QUESTIONS 6.5

i. Which latitude receives the maximum amount of insolation?

ii. What is the nature of "Sirocco" wind and where is it blown?

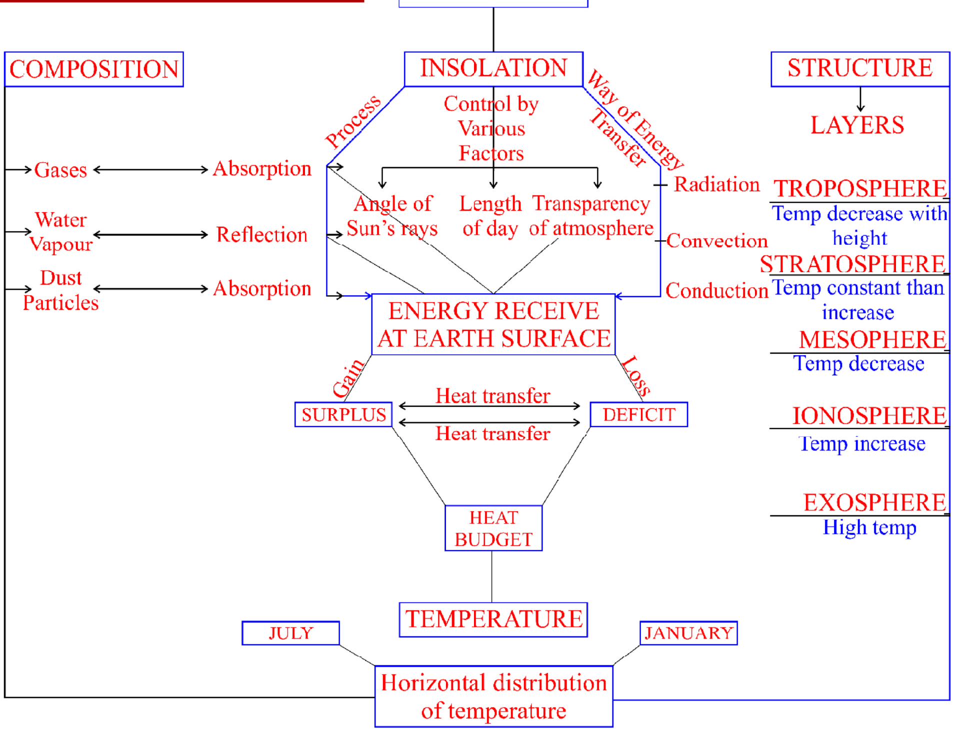
iii. Which months represent seasonal extremes of temperature on the globe?

iv. In the southern hemisphere, which season is found in the month of January?

ACTIVITY

Make lists of various examples which represent processes of energy transfer.

WHAT YOU HAVE LEARNT



TERMINAL QUESTIONS

1. What are the three mechanisms by which heat energy is transferred?

2. Write a note on the important gases of the atmosphere.

3. Explain different layers of the atmosphere with the help of a diagram.

4. Distinguish between convection and radiation ways of heat transfer.

5. Why do Poles receive less amount of insolation?

6. Describe important factors of horizontal distribution of temperature.

7. Identify surplus and deficit zones of energy on earth.

8. Describe heat budget with the help of diagrams.

ANSWERS TO INTEXT QUESTIONS

6.2

(i) T (ii) T

(iii) F (iv) F

6.2

(i) Troposphere (ii) Ozone gas and Stratosphere

(iii Ionosphere plays an important role in radio communication.

(iv) Exosphere

6.3

(i) Incoming solar radiation is known as insolation.

(ii) Angle of incidence, length of day, transparency of atmosphere.

(iii) Radiation (iv) Equator

6.4

(i) Amount of reflected solar energy is known as 'Albedo'.

(ii) Heat budget is the balance between incoming and outgoing radiation.

(iii) 51% (iv) Zero

6.5

(i) Low latitudes

(ii) Hot wind and blowing towards Italy.

(iii) January and July

(iv) Summer season

7

ATMOSPHERIC PRESSURE AND WINDS

You have learnt in the previous lesson about the atmosphere's composition and its structure, insolation, distribution of temperature and heat budget. We all can feel the sensation of moving air. Have you ever thought about why it moves or what is the reason behind the movement of air? You have also observed its speed and frequency which vary from one place to another. It is all due to variation in the atmospheric pressure which is controlled by temperature.

In this lesson, you will learn about atmosphere pressure, factors affecting atmospheric pressure, pressure belts, planetary and local winds.

OUTCOMES

After studying this lesson, learner:

- defines atmospheric pressure;
- explains factors affecting atmospheric pressure;
- describes atmospheric pressure belts; and
- distinguishes between planetary and local winds.

7.1 ATMOSPHERIC PRESSURE

As we have learnt that, the air is the mixture of gases, water vapour and dust particles. The air with heavy weight means gases, water vapour and dust particles come together or air particles are compressed, while in low weight or pressure, air particles are dispersed or located far to each other. This weight of the air is known as air pressure or atmospheric pressure.

In other words, the mass of the air molecules can define atmospheric pressure. It is measured at a particular surface per unit area. It acts as a force on the earth's surface. It may be measured at any surface. Therefore, the total mass of the air column above that surface is

Notes

compressed for measuring air pressure. This air pressure on the earth's surface varies from place and over time.

The air pressure is measured by Barometer. The atmospheric pressure measuring unit is Millibar (mb). The atmospheric pressure is maximum at sea level. The standard sea level atmospheric pressure is 1013.2 mb.It is because above sea level the thickness of the atmosphere is greater, so the atmospheric pressure is highest. You might have gone to some hill stations. Those hill stations have more height then plain or sea coast. Hence, the air pressure over hill station is less because air parcel is less, hence the pressure is less.

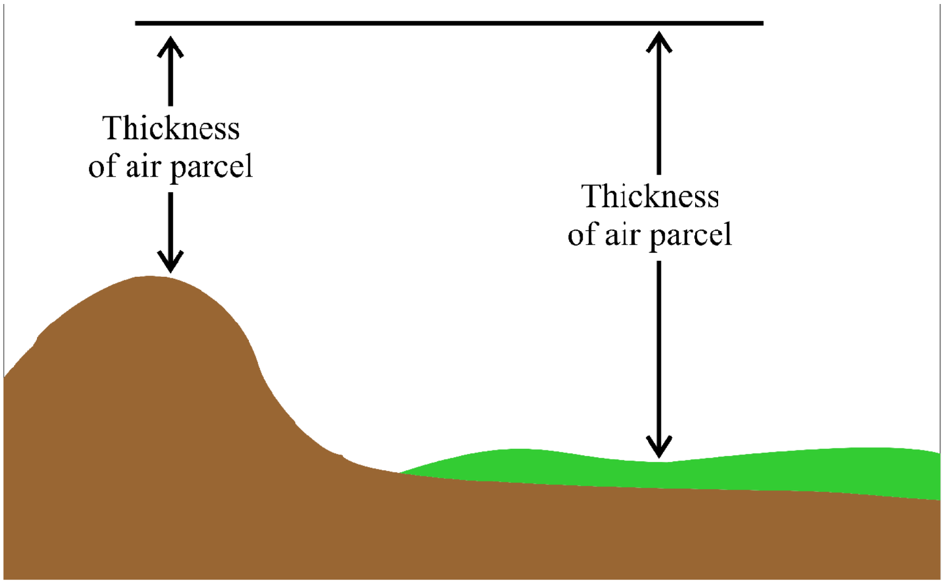


Fig 7.1 Pressure decreases with Height

Air pressure can be shown by Isobars lines on a weather map. It means all the places with same air pressure is joined by a line and the line is known as isobars.

Mainly, there are two types of atmospheric pressure; high pressure and low pressure. The pressure variations can be identified by the shape of isobars. On the earth's surface, an area with more air is known as high pressure areas and an area with less air is known as low pressure areas. In a high pressure system, pressure decreases outward from the centre and in the low pressure system pressure decreases towards the centre. The high and low pressure is the result of temperature differential in the atmosphere.

The difference in atmospheric pressure between the two places on the surface is known as Pressure Gradient. The pressure gradient is a result of differential heating over space. Through the study of spacing between isobars, we can understand pressure gradients. Small difference in pressure over large space indicates weak gradient while close spacing of isobars express strong pressure gradient. As air is a compressible fluid, due to the pull of gravity it is most dense near the ground surface. Moreover, it also decreases rapidly with height.

There are two types of air motion i.e. horizontal and vertical. Convergence and divergence of air is an example of horizontal motion. Whenever winds flow towards each other or converge, besides this when surface winds diverge there must be a subsidence of the air. Ascent and subsidence is an example of vertical motion.

DO YOU KNOW?

On a weather map for a designated place, where sea-level atmospheric pressure is comparatively high, pressure is expressed with symbol "H" and low pressure with "L" symbol.

Let us see figure which shows convergence and divergence associated with high and low pressure systems.

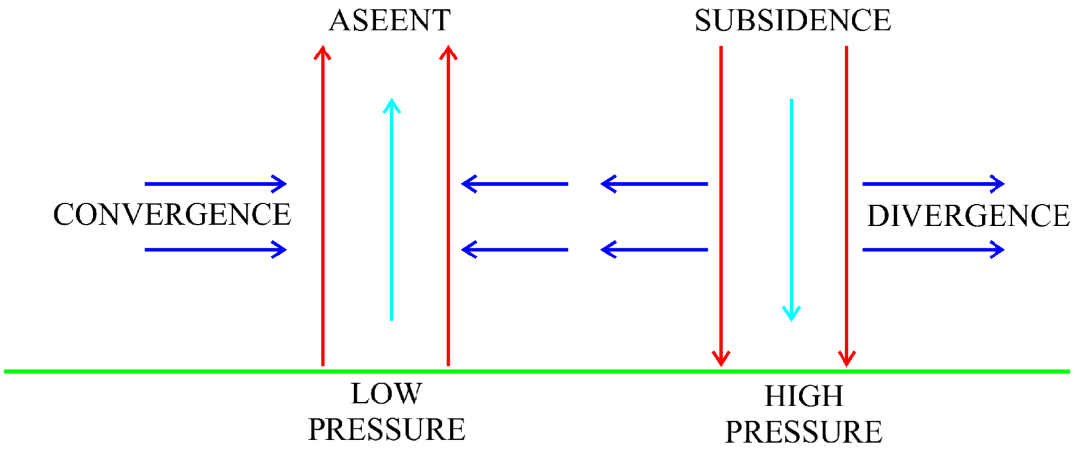


Fig 7.2 Horizontal and vertical movement of Air

The low-pressure regions are associated with clouds and precipitation while the high pressure system is generally associated with dry weather and mostly clear skies with longer diurnal temperature changes; due to greater radiation at night and greater sunshine during the day.

INTEXT QUESTIONS 7.1

Give an appropriate term for the following:

1. A force per unit area exerted by the atmosphere above earth's surface.

2. Name the term by which air pressure is shown on the map?

3. An instrument which is used for measuring air pressure.

4. Name the term showing the difference between two isobars?

7.2 FACTORS AFFECTING ATMOSPHERIC PRESSURE

Till now, you have learned that atmospheric pressure varies with time and space. Let's discuss why and how? In this regard, the following factors need to be studied which affect atmospheric pressure.

i. Altitude

ii. Temperature

iii. Earth Rotation

iv. Water Vapour

Let's discuss one by one.

I. Altitude

Atmospheric pressure decreases with increasing height. It means pressure at ground level is higher than air pressure at the top of High Mountain. Because atmospheric pressure is the weight of all the air above the level at which it is measured.

- Height of the air column is maximum at sea-level and that's why pressure of air is greater at ground level than less pressure at higher elevations.
- As we know, air is highly compressible and a mixture of various gases. Due to the weight of overlying layers, density of lower layers is increased. Its atmospheric pressure increases at lower layers of the atmosphere.
- Heavy gases and particles are found at lower layers and lightweight gases and fewer particles float at higher layers.

DO YOU KNOW?

Atmospheric pressure decreases with increased altitude but rapidly at lower atmosphere then slowly at high altitude.

ii. Temperature

The atmospheric pressure is closely linked with atmospheric temperature. It means the spatial variation in the atmospheric pressure is directly controlled by the temperature. There is an inverse relationship between temperature and pressure because when air is heated due to high temperature, its molecules and particles expand over a large area. Its air pressure decreases. Therefore, we can say, atmospheric pressure decreases when temperature increases. When air is cooled, it contracts and air molecules spread

Notes

only at smaller areas. Because of this phenomenon, the pressure of the air increases. In other words, atmospheric pressure increases when the temperature falls.

Let's understand the impact of temperature on pressure through flow diagram

Low air temperature → Shrunk → Density increase → pressure increase
High air temperature → Expand → Density decrease → Pressure decrease

For example, you have already learned in the last lesson that the temperature is very low at the poles and high mountain regions which results in the contraction of the air. Thus, high pressure areas develop at poles. On the other hand, high temperature along the equator and near earth's surface results in expansion of the air and development of low-pressure areas.

iii. Earth's Rotation

Earth's rotation also makes a great impact on pressure belts of the globe. Due to the earth's rotation on its axis, equatorial air moves far away from the centre while polar air attracts towards the centre. As a result, the air column of mid latitudes changes more. Atmospheric pressure is high at lower layers of the atmosphere due to the gravitational pull of the earth.

iv. Water Vapour

The existence of water vapour also affects the atmospheric pressure. The greater the concentration of water vapour in the air, the density of air is less. Air with lower water vapour makes it heavy or high in density. Because the molecular weight of water is less than the average molecular weight of dry air. Thus, dry air is heavier than moist air. Similarly, the air is lighter in the rainy season due to the presence of water vapour.

DO YOU KNOW?

Water vapour reduces the density of air and thus the light air exists on oceans and heavy air on continents.

INTEXT QUESTIONS 7.2

Write 'True' for correct and 'False' for incorrect statements-

i. There is an inversely proportional relationship between temperature and pressure.

ii. The maximum atmospheric pressure is at the mountain top.

iii. Earth's rotation on its axis affects the pressure especially in mid latitude.

Notes

iv. Continental airs are lighter in weight than oceanic air.

7.3 DISTRIBUTION OF ATMOSPHERIC PRESSURE

It is very important to know about the distribution of the atmosphere. Its distribution varies spatially, diurnally and seasonally. Here, you are going to learn vertical and horizontal distribution of atmospheric pressure.

A. Vertical Atmospheric Pressure

Generally, Atmospheric pressure decreases with increasing height at the rate of 34 the millibars per 300 metres of height. For example figure shows how altitude affects the pressure distribution. At the height of 5.5 kms air pressure decreases to 550 mb which is half of the sea-level pressure. In other words, we can say that half of the atmospheric mass lies between the earth's surface and the height up to 5.5 kms. In this way, at the altitude of 50 kms, air pressure is about 1 mb. Out of total atmospheric pressure, 99.9 percent lies within 50kms of the earth's surface.

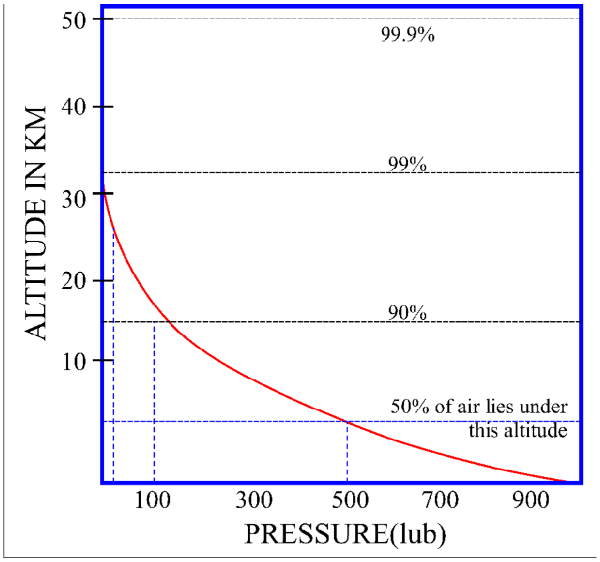


Fig 7.3 Vertical air Pressure and Altitude

B. Horizontal Distribution of Atmospheric Pressure

As you know, the distribution of air pressure is shown by Isobars. Isobar means the line which connects those places having equal pressure. After studies of pressure distribution, we can say there is a close relationship between pressure and temperature. The horizontal distribution of atmospheric pressure is controlled by some factors. It can be categorised in two groups' i.e. thermal factor and dynamic factor. There are clearly distinguishable homogeneous pressure belts at global level. On that basis, Earth can be divided into seven pressure regimes or belts in which three pressure belts in each hemisphere and one lies near the equator in both hemispheres.

Notes

i. **Equatorial low pressures belt:** Equatorial low-pressure belt lies between 5° north and 5° south latitudes. This region receives intense heating throughout the year; air gets warmed up and rises over the equatorial region and creates low pressure. The vertical upward movement of air is the main reason for creating low pressure at the surface of the equatorial zone. The position of this low-pressure belt varies with apparent movement of the sun.

   This belt is the zone of convergence of trade winds from subtropical high pressure belts of both the hemisphere. It is known as Inter Tropical Convergence Zone (ITCZ). In this zone winds are very light and variable with frequent calms. It is also called the doldrums. The position of the belt varies with the apparent movement of the sun.

ii. **Sub-tropical high-pressure belt:** Sub tropical high-pressure belt extends from 30° to 35° in north and south latitudes. The following two reasons are responsible for creating high pressure in this region even after intense heating of about 10 months in a year. Here the dynamic factor is responsible for high pressure.

   - Due to subsidence of air at 30° north and south latitude, which rises over the equator and moves towards poles and descends after becoming cold and heavy in the upper troposphere.

   - Due to the earth's rotation, poleward moving winds are deflected from polar areas to sub-tropical areas and cause high pressure near tropics.

     The descending air creates dry, calm conditions with variable and light winds in this high-pressure region. Therefore, they are called 'belt of calm' or 'horse latitudes'. Most of the hot deserts are located in the western side of this belt in both the hemispheres.

iii. **Sub - Polar low-pressure belt:** The sub - polar belt located around 60° north and south latitude. Here, low pressure exists as a result of convergence of westerlies and polar easterlies. Due to great contrast between the temperature of the winds from subtropical warm and polar cold regions produce cyclonic activity in this region.

   This sub-polar low-pressure area is best developed over the oceans where temperature differences between summer and winter are negligible.

iv. **Polar high-pressure belt:** The Polar high-pressure belt situated on the north and south poles at 90° in both the hemispheres where temperature is extremely low below freezing point. It causes air compressions and density increases. Thus, create a belt of high-pressure.

On the basis of the above explanation, equatorial low pressure belt and polar high pressure belt are thermally induced while sub tropical high pressure belt and sub polar low pressure belt are dynamically induced. Above pressure belts are just a generalised picture, not permanent. Because they change their position and shift northward in July and southward in January.

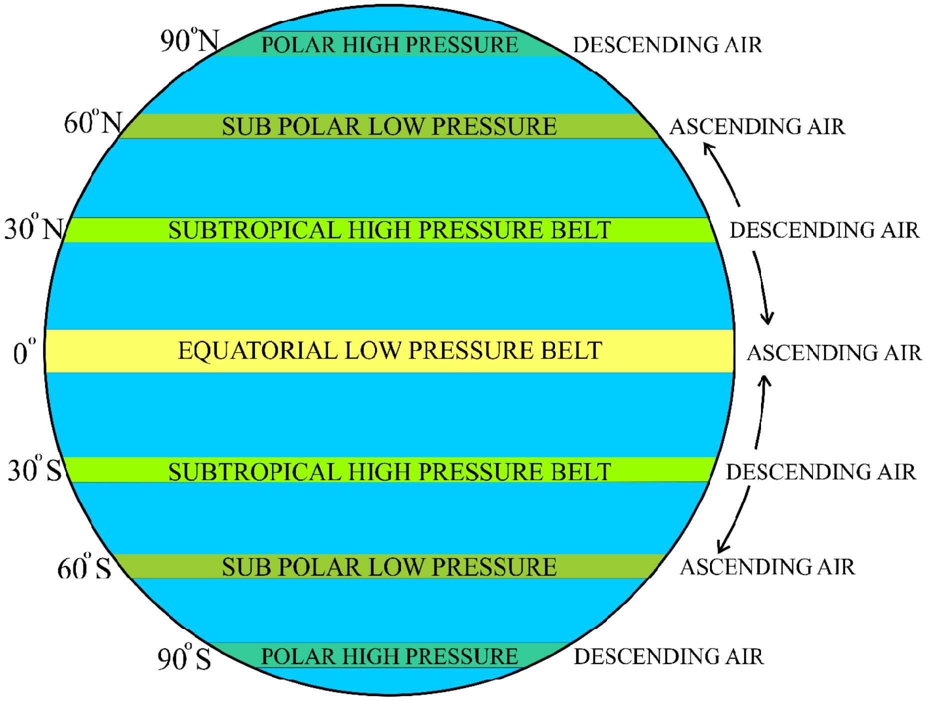


Fig 7.4 Distribution of world pressure belt

C. Seasonal Distribution of Pressure

The pressure variation from place to place and season are important in respect of weather and climate. The variation can be analysed by the study of isobar maps. Pressure of all places drawn on an isobar map is reduced to sea level to avoid the effect of altitude on air pressure. World isobaric maps are generally constructed to show average pressure for two months - January and July.

i. Pressure conditions of January

In the month of January, the apparent movement of the sun is towards the Tropic of Capricorn. This is the time of summer in the southern hemisphere. The equatorial low pressure belt shifts little towards the south. The areas of lowest pressure occur over the warm continents of Australia, Africa and South America. We know land tends to get hotter rapidly than water and the subtropical high-pressure cells are centred over the ocean in the southern hemisphere. The high pressure belt is interrupted by the continental land masses where the temperature is much higher. There are well - developed

circumpolar belts of low pressure in the southern hemisphere. This is due to no land masses in the high latitudes. It has also been observed that over the coastal regions of Antarctica and the southern oceans clearly indicate that beyond latitude 65° south, there is a gradual increase in the atmospheric pressure.

In the northern hemisphere, the sub - tropical high pressure belt is located well to the north mainly over the continents. The high pressure exists over North America and Eurasia. This is due to the fact that land cools more rapidly than oceans. Its temperature is lower in winter than the surrounding seas. The north - eastern part of Asia has the highest pressure on the earth's surface. Because of large continental areas in the northern hemisphere the sub-polar low-pressure belt is represented by individual oceanic cells and their continuity is broken. There are two low pressure cells namely Iceland low and Aleutian low develop over the north atlantic and north pacific oceans respectively in the northern hemisphere.

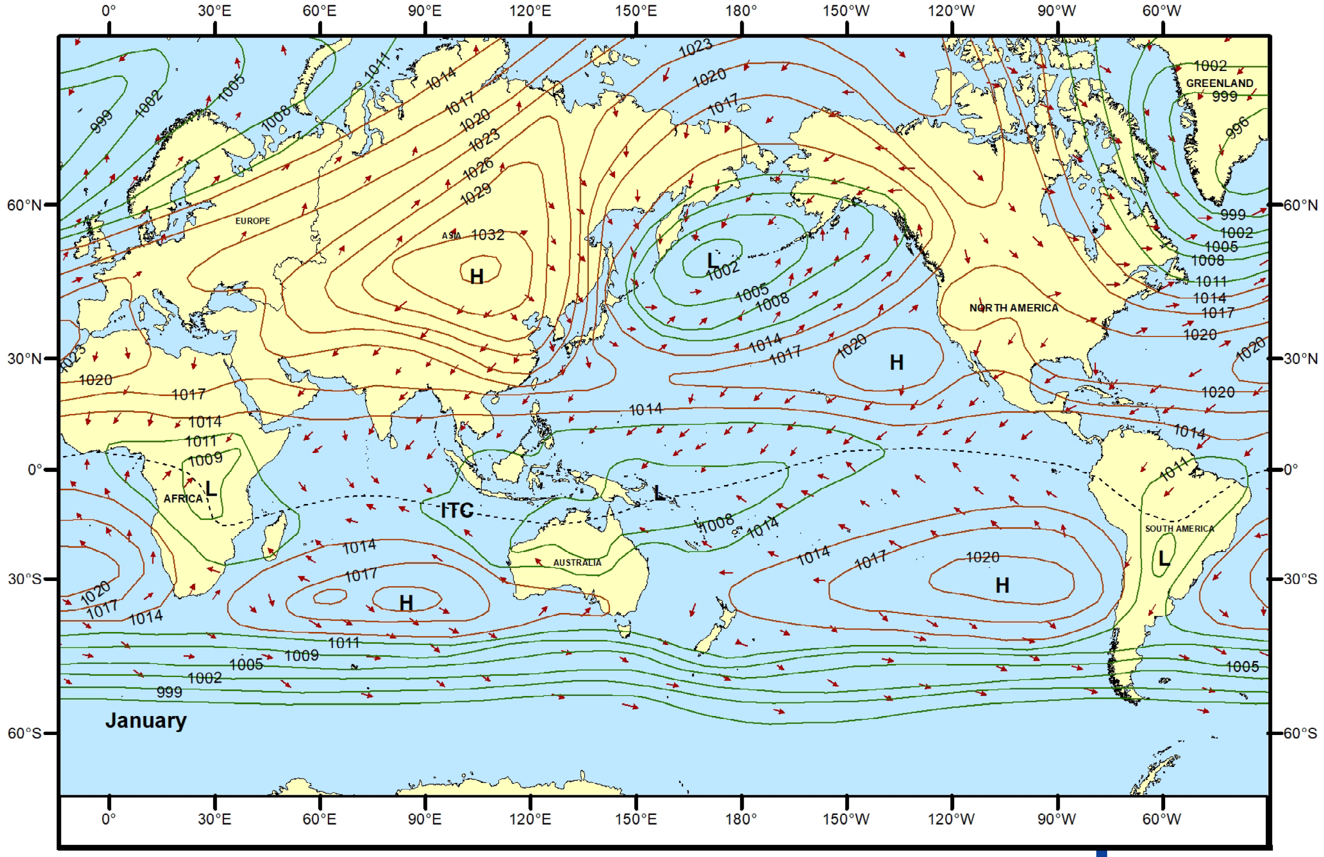


Fig. 7.5 Pressure Condition in January

ii. Pressure conditions of July

This is the season of summer in the northern hemisphere because of the apparent movement of the sun towards the Tropic of Cancer. Therefore, all pressure belts shift northward. Equatorial trough is located well north of the equator over the warm land

mass. The sub - tropical high-pressure cell is more developed and found over the north atlantic and north pacific. They are called the Azores high and the Hawaiian high. There is a winter season in the southern hemisphere. The subtropical high pressure belt is a continuous and high pressure cell established over the continent of Australia. The Sub - polar low forms a continuous belt in the southern hemisphere. In the northern hemisphere, the sub polar low-pressure belt continues to a small degree over oceans.

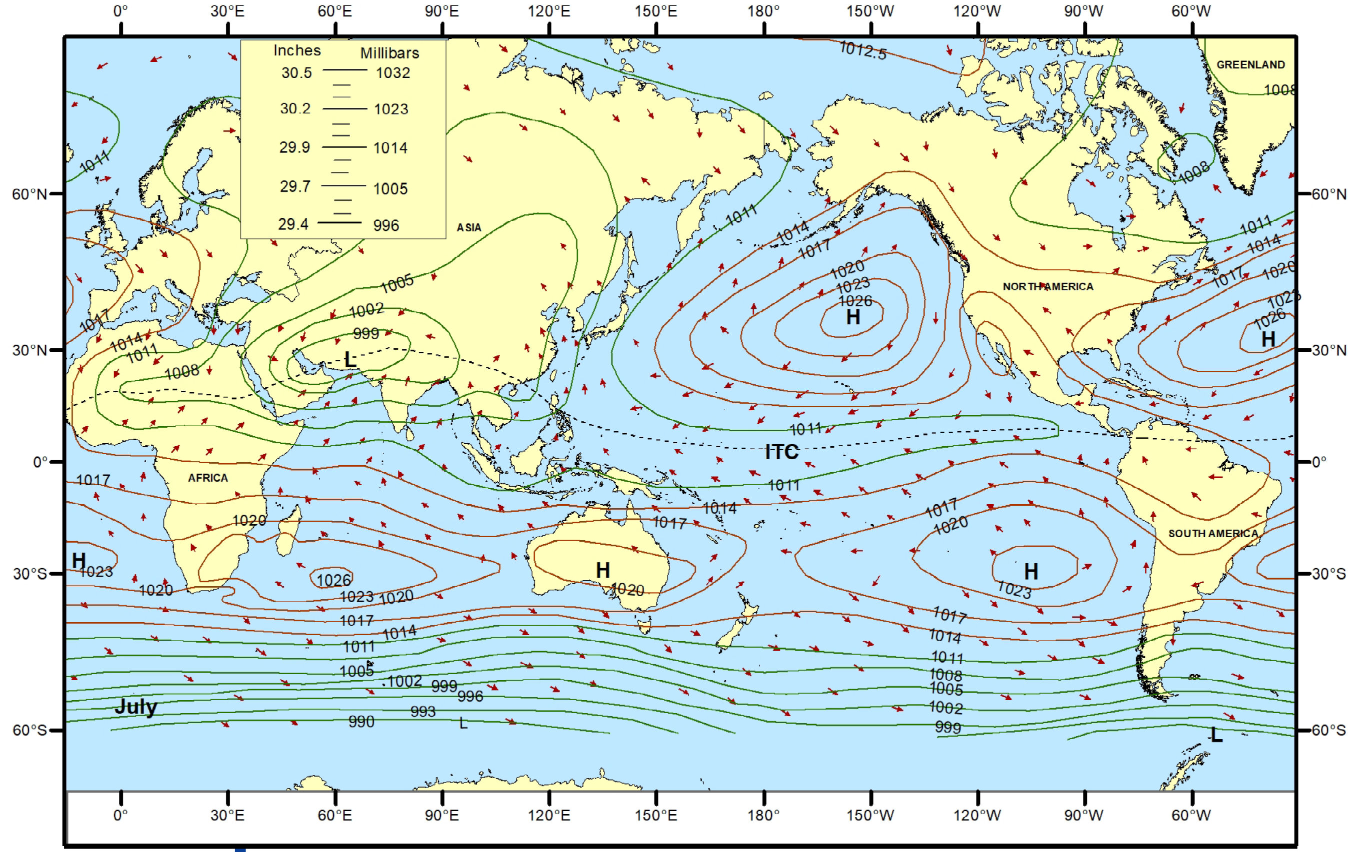


Fig. 7.6 Pressure Condition in July

INTEXT QUESTIONS 7.3

i. What is the other name of inter tropical convergence zone?

ii. Name the pressure belt which is related to horse latitude.

iii. Which factor is responsible for the sub-polar low pressure belt?

iv. Name the continents where the low pressures exist in the month of January.

7.4 WIND

Wind is the common name to use for the movement of air from one place to another place. The nature of wind, its speed and frequency vary from one place to another due to the variation in the atmospheric pressure. Air moves wherever and whenever the pressure difference exists in the atmosphere.

Technically, wind is the horizontal movement of air molecules over the earth's surface. It is the result of spatial difference in the air pressure. Wind is one of the important modes of equalisation of the atmosphere, transporting heat, moisture, pollutants and dust to a great distance around the globe.

We have learnt in previous lessons that water and air are important in maintaining the heat budget of the earth surface. Like water in the oceans through the motion of wind, transfer heat over the earth's surface and carries water vapour from ocean to the continents. Life is possible on earth's surface only because of this heat transfer from equator to poles and poles to equator. Winds also influence various economic activities and human comfort. They not only have a larger impact at global level but they have also influence at local level. Winds tend to blow from the high-pressure belts to the low-pressure belts. Air direction and velocity are two important characteristics of wind.

A. Factors Affecting Wind Motions

An air movement is a normal phenomena of the atmosphere. It moves as the difference in atmospheric pressure develops. The Pressure gradient plays an important role in air movement and controls the direction and speed of the air. Once air moves along the pressure gradient, several other forces affect its direction and velocity. For example, instead of blowing directly from one pressure belt to another, winds tend to deflect the direction of the winds due to the effect of earth's rotation.

Pressure gradient is defined as difference in pressure over space. The difference in pressure gradient is due to the difference in heating over space. The two key factors affect wind motion are:

i. **The pressure gradient force:** The pressure gradient force has been generated due to horizontal difference in pressure which is a result of uneven heating. With the effect of this force air moves from high pressure areas to low pressure areas, without this difference air cannot move. It means the wind direction follows the direction of change of pressure. Not only wind direction but wind speed is also controlled by the pressure gradient force. For example, closely spaced isobars indicate steep pressure gradient and large space between isobars is an example of weak gradient. The pressure gradient is the force that determines the strength of the wind.

Notes

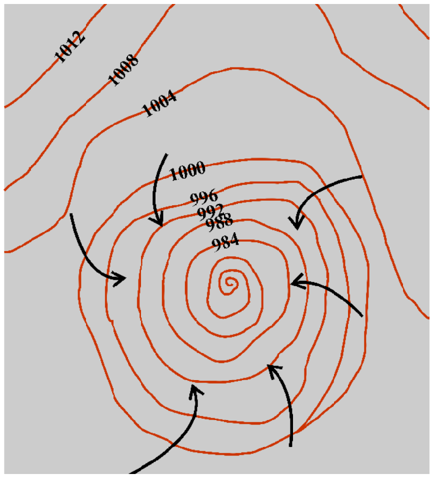


Fig 7.7 ISOBAR showing steep pressure Gradient

ii. The Coriolis force: Normally winds will follow the direction of pressure gradient. But it is not like this, winds do not cross the isobars at right angles according to pressure gradient. Therefore, winds are greatly deflected by their original path due to Coriolis force which is a result of rotational movement of earth on its axis. The effect of Coriolis force can be stated as any object and liquid moving horizontally tends to be deflected to the right to its path of motion in the northern hemisphere and deflection towards the left of the path of motion in the southern hemisphere. The Coriolis Effect is absent (0) at equator but increases towards the poles (100%).

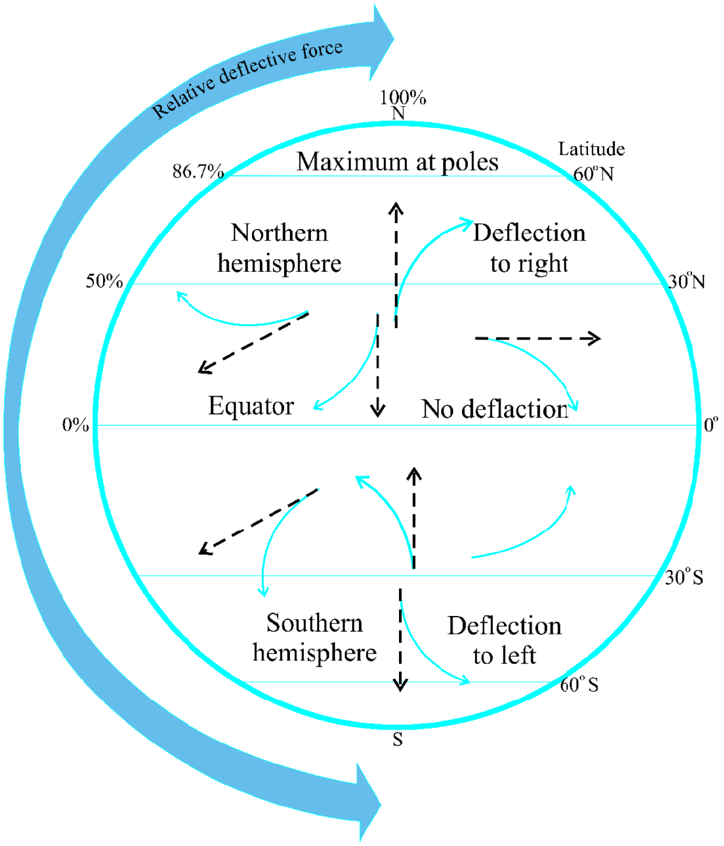


Fig. 7.8 The coriolis force

Notes

B. Types of Winds

Winds play an important role in understanding the climatic characteristics of different parts of the world or our surroundings. There is a closer relationship between winds and the belt of atmospheric pressure. Throughout the world there are many wind systems which influence not only our economic activities but also our comfort. Winds are classified broadly in following categories.

a. Planetary winds or permanent winds

b. Periodic or seasonal winds

c. Local winds

a. Planetary winds- The planetary winds blow from high pressure areas to low pressure areas in the same direction throughout the year. These winds blow extensively over the continent and oceans. They are known as the easterlies or trade winds, westerlies and polar easterlies.

i. The Easterlies or Trade winds - The Easterlies winds blow from sub- tropical high-pressure areas towards equatorial low-pressure areas. It is also known as trade winds. The direction of these winds in the northern hemisphere is from north-east to south - west and southern hemisphere south - east to north - west. The deflection of winds is a result of Coriolis Effect. Because winds tend to blow out of the east, they are called easterlies.

These winds are stable in their area of origin and when they reach the equator becomes humid after picking moisture on their way. The Trade winds of both the hemisphere meet at equator and due to convergence, they rise and cause heavy rainfall.

ii. Westerlies -The westerlies are the winds which blow towards poles from sub - tropical high-pressure belts in the northern hemisphere deflected to the right and blow from south-west to north-west. In contrast wind deflected to the left in the southern hemisphere and blew from north-west. Thus, these winds are called westerlies. In the southern hemisphere, there is a vast expanse of ocean. Therefore, westerlies blow with great force and regularly throughout the year between 40° south latitude to 60° south latitudes. Due to their tremendous speed they are known as Roaring forties, Furious fifties and Shrieking sixties.

iii. Polar easterlies- The polar easterlies blow from polar high pressure regions towards sub-polar low pressure regions. It blows from the north east to the south west direction in the northern hemisphere. In the southern hemisphere, the direction of wind is from South-East to North-West. The Polar easterlies have characteristics of being extremely cold, dry and stable.

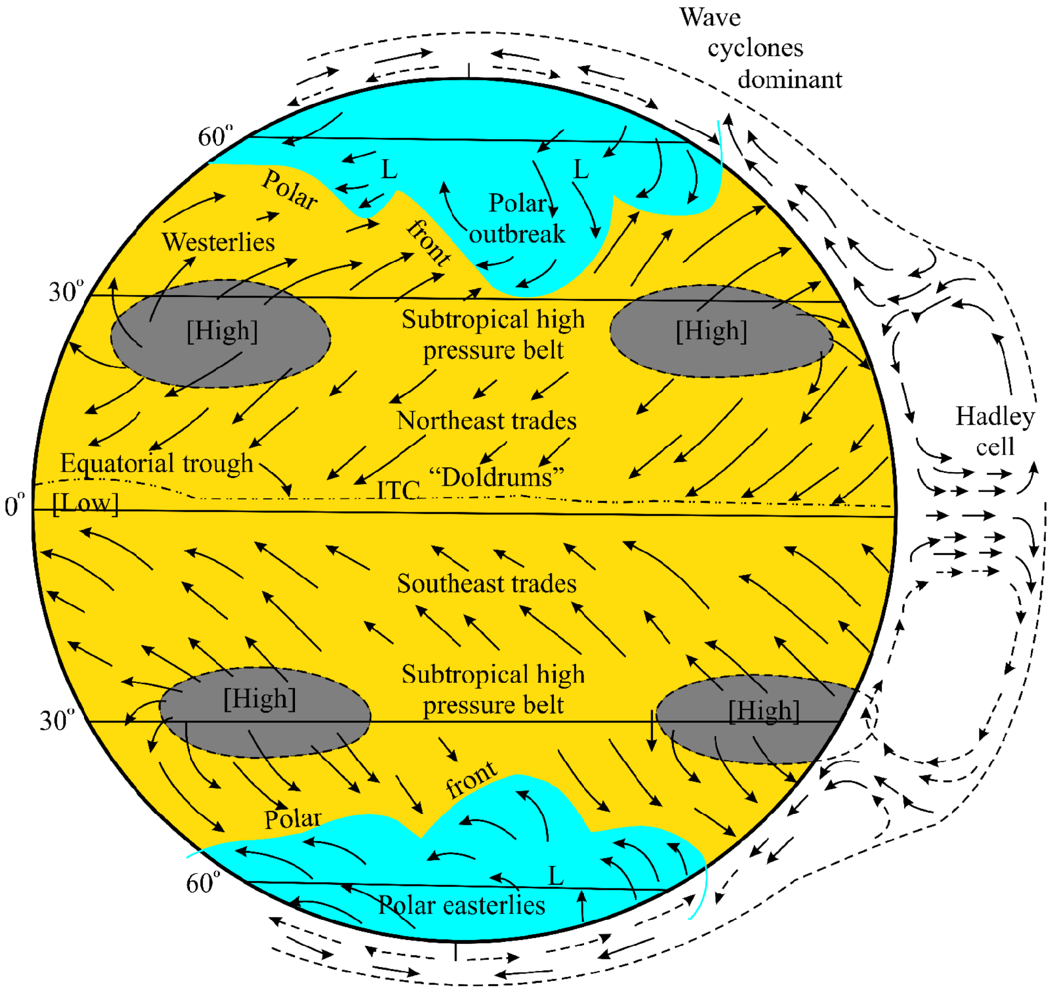


Fig.7.9 Planetary Winds

b. **Periodic winds -** The Periodic winds are those winds which change their direction with the change of seasons. This is also known as seasonal winds. Monsoon winds are the best example of periodic winds.

i. **Monsoon winds -** The word "monsoon" is described as a wind of seasonal reversal. It means monsoon winds are those seasonal winds which completely reverse their direction with the change of seasons. Monsoon winds blow from sea towards land in summer seasons and from land towards sea in winter. They blow on an extensive area of the Asian continent, and other parts of the world. Monsoon of Asian region is the result of interaction of both planetary wind systems and regional factors, both at the surface and in the upper troposphere. The most important areas of monsoon climate are located in India, Burma, Bangladesh, China, and Philippines etc.

India truly represents monsoonal climate. The climate of India is marked by distinct winter and summer seasons. The rain comes in summer in one part of the country and in winter in another part.

c. **Local winds -** Local winds develop due to local differences in temperature and pressure. Such winds affect small areas in extent and are confined to the lowest level of the troposphere. Some examples of local winds are as follows:

i. **Land and Sea Breezes-** Land and sea breezes are a good example of the change in temperature and pressure of the air over land in contrast to that over water. The land and sea absorb and transfer heat differently. In the daytime the land area gets more heated and becomes warmer than the adjacent sea. Thus, over the land the air rises and develops low pressure. Whereas the sea is relatively cool and pressure over sea is comparatively high. Therefore, pressure gradient from sea to land is created. Wind blows from sea to land as 'sea breeze'. At night the reversal of conduction takes place. After sunset land loses heat faster and becomes cooler than the sea. This results in high pressure over the land and low pressure over the sea. The pressure gradient is from the land to the sea. Air starts blowing from land to sea and it is known as 'land breeze'.

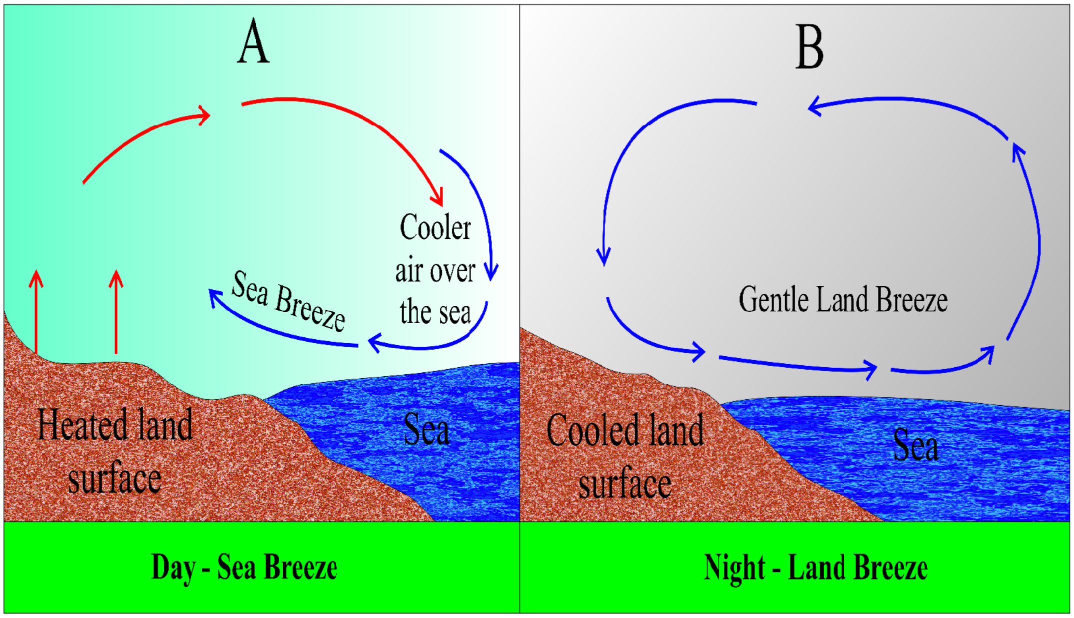


Fig. 7.10 Sea and land Breezes

ii. **Mountain and Valley Breezes-** A mountain and valley breeze is an example of a diurnal wind system. It develops frequently over areas with large differences in relief or some highland areas. During the day , the sun heats up the valley air rapidly. This causes it to raise a warm, upslope wind. The warm air rises creating a valley breeze. In the night mountain air cools rapidly and cold air is dense so it sinks from the mountain tops into the valley below creating a mountain breeze. A mountain breeze and a valley breeze are two related, localised winds that occur one after the other on a daily cycle.

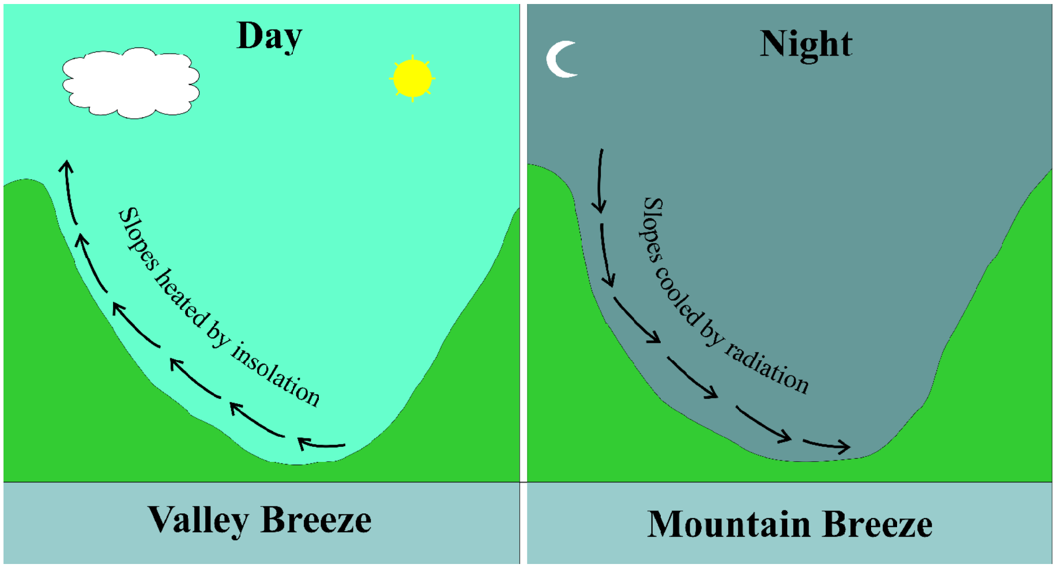


Fig 7.11 Valley and Mountain Breezes

iii. Hot winds

Let's know about some of the important hot winds.

Name of hot winds	Location	Characteristics
Loo	Plain of north India and Pakistan	Loo is a very hot and dry wind, which blows in the months of May and June, usually in the afternoon. Its temperature varies from 45 degree Celsius to 50 degree Celsius.
Fohn	Alps mountain	The fohn is warm, dry, gusty wind which occurs over lower slopes on the lee side of a mountain barrier. The onset of fohn is generally sudden. It may raise the temperature by 15 degrees to 30° F within an hour.
Chinook	Eastern slopes of Rockies	A very dry and warm wind with a capacity to evaporate snow. The meaning of chinook is 'the Snow eater'. Chinook have been known to raise temperature by 35° F within 15 minutes.
Leveche	Spain	A dry, dust laden wind blowing from Sahara Desert into Spain
Sirocco	Sahara desert	A hot, dry wind blowing north across the Mediterranean sea.

Khamsin	North Africa and Arabia	A hot desert, dry, dust- laden, wind occurring mainly in Egypt. It occurs during the period February to June, being most frequent in March and April.
Zonda	Argentina	A warm, dry wind on the edge of the Andes.
The Santa Ana	Southern California	A hot, dry, strong, blustery, fohn-type wind. It is most frequent in winters but may also occur in spring or autumn. In spring Santa Ana winds can cause considerable damage to fruit trees.
Harmattan	West Africa	A hot, dry, dusty north-eastern wind blowing out of the Sahara across the Sahel. It is hot from about March to June and cool from November to February.

iv. Cold winds

Some of the important cold winds are:

Name of cold winds	**Location**	**Characteristics**
Bora	Adriatic coast	A cold, dry winter, blowing down off the highlands of Yugoslavia and affecting the Adriatic coast.
Blizzard	Rocky Mountain	An extremely cold, violent, storm of powdery snow ice carried by a high wind during which visibility is limited.
Buran	Central Asia and Russia	A extremely cold, strong northeasterly or easterly winds blowing found in central Asia and Russia chiefly during the winter
Mistral	Rhone valley	A strong, cold, dry and violent wind originates on the Alps in france. It blows from north or north-west towards the Mediterranean through the Rhone valley. It may blow any time of year continuously for a day or two with speeds of 100 km/h.

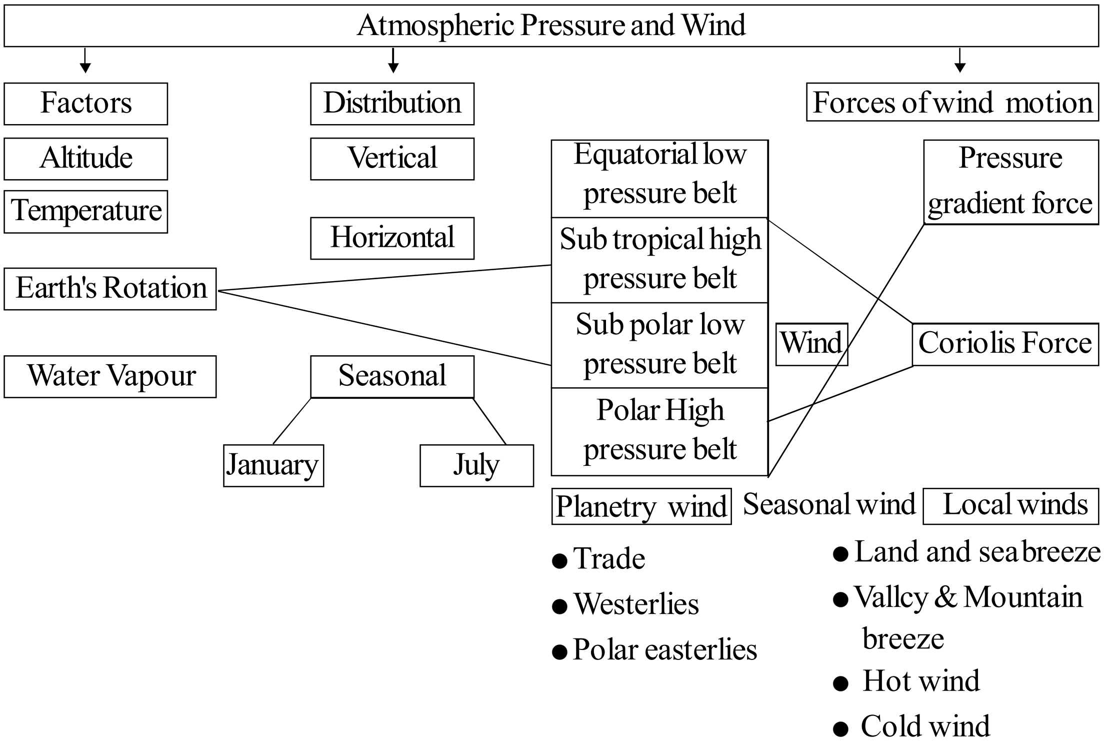
Norther	Texas, Gulf of Mexico to W. Caribbean	A cold, strong, northerly wind whose rapid onset may quickly drop the temperature. Severe thunderstorms and hail are common and the wind can reach speeds of between 40 and 60 mph.

The distinctive wind patterns from planetary to local in various parts of the world are the result of variation in atmospheric pressure.

INTEXT QUESTIONS 7.4

1. Name the forces of wind motions.
2. Give an example of planetary winds.
3. Loo, Chinook and Sirocco are examples of which type of wind?
4. What is the main characteristic of Monsoon winds?

WHAT YOU HAVE LEARNT



ACTIVITY

Let's make a map showing different winds of your area and try to find out their reason for movement.

TERMINAL QUESTIONS

1. Choose the correct answer for each of the following:

   a. Sirocco is a type of wind.

      (i) Hot local wind

      (ii) Cold local wind

      (iii) Seasonal wind

      (iv) Planetary wind

   b. Where is the maximum deflective force ?

      (i) Equator

      (ii) Tropics

      (iii) Poles

      (iv) Mid latitudes

   c. Which one is a example of periodic wind

      (i) Land and Sea Breezes

      (ii) Westerlies

      (iii) Monsoon

      (iv) Fohn

2. Name the factors on which the atmospheric pressure of any place depends.

3. Define atmospheric pressure and how it can be measured?

4. Write a short notes on following:

   a. Pressure gradient force

   b. Land and sea Breezes

5. Distinguish between the following:

a. Planetary winds and Periodic winds

b. Mountain and Valley Breezes

6. Explain the role of Coriolis force in wind motion.

7. With the help of diagrams show the various pressure belts of the earth surface.

8. Describe any two planetary winds.

9. Explain the seasonal variation in pressure distribution of earth with the help of a map.

ANSWERS TO INTEXT QUESTIONS

7.1

(i) Atmospheric pressure

(ii) Isobar

(iii) Barometer

(iv) Pressure gradient

7.2

(i) True

(ii) False

(iii) True

(iv) False

7.3

(i) Doldrums

(ii) Subtropical high pressure belt

(iii) Dynamic factor

(iv) Australia, Africa and South America

7.4

(i) Pressure gradient force and Coriolis force.

(ii) Trade winds, Westerlies and Polar easterlies.

(iii) Hot winds

(iv) Seasonal reversal of winds is the main characteristic of monsoon winds.

8

HUMIDITY AND PRECIPITATION

The air that surrounds us contains water in the form of vapour. Sometimes we can see it around us in the form of fog or mist or clouds above us. Through water vapour is a minor component of the atmosphere, yet it is a very important element of the atmosphere. In this lesson, we will study the role of water vapour in day-to-day weather conditions. Heat and water are vital ingredients of the biosphere. Plant and animal life on which our life depends need fresh water. The only primarybasic source of water is from the atmosphere through the condensation of water vapour. In this lesson, we are mainly concerned with water in the vapour state in the atmosphere and the process by which it passes into the liquid or solid state and ultimately arrives at the surface of oceans and lands through the process of precipitation.

OUTCOMES

After studying this lesson, learner:

- distinguishs between absolute and relative humidity;
- explains evaporation and the factors affecting the rate of evaporation;
- explains condensation and its various forms;
- explains conditions required for precipitation;
- explains types of rainfall with a diagram;
- describes various forms of precipitation and
- identifies factors affecting the distribution of precipitation.

8.1 IMPORTANCE OF WATER VAPOUR

Thus the presence of water vapour in the air is an extremely important factor for the existence of human being on the earth. It is the most variable gas inof the atmosphere with a proportion

varying from almost zero to as much as four percent by volume.

Importance of water vapour is given below:

1. Precipitation occurs on account of water vapour.
2. Water vapour in the atmosphere absorbs a significant portion of both incoming solar radiation and outgoing earth radiation. It helps in maintaining a suitable temperature on the earth.
3. The amount of water vapour present in the air affects the rate of evaporation.
4. The water vapour provides necessary energy needed for storms (cyclones, hurricanes etc)Necessary energy needed for storms (cyclones, hurricanes etc) is provided by the water vapour in the form of latent heat energy.
5. The amount of water vapour present at a place or region indicates the potentiality of precipitation
6. Air poorly in water content makes our body skin dry and rough.
7. The presence of water vapour present in the air also affects standing crops.

8.2 HUMIDITY

Humidity is the concentration of water vapour present in the air. Water vapour, the gaseous state of Water, is generally invisible to the human eye. Humidity indicates the likelihood of precipitation, dew or fog to be present. Humidity depends on the temperature and pressure of the System. It also indicates the degree of dampness or Wetness of the air. Humidity of the air is mainly expressed in the following two ways-

A. Absolute Humidity

The amount of actual water vapour per unit of air is known as absolute humidity and expressed in grams per cubic metre of air. For example, if the absolute humidity of air is 10 grams, it means that one cubic metre of that air holds 10 grams of moisture in the form of water vapour. Absolute humidity is variable and changes from place to place and with change in time.

The capacity of air to hold water vapour fully depends on temperature. The capacity of holding water vapour in the air increases with the increase in temperature. For example at 10° C, temperature one cubic metremeter of air can hold 9.4 grams of water vapour. If the temperature is increased to 20°C, its Capacity to hold water vapour also increases to 17.12 grams per cubic metre of air. Likewise at 30°C temperature it may rise to 30.04 grams per cubic metremeter of air At Certain temperatur the quantity of water

Notes

vapour held per cubic metre of air is known as its capacity to hold water vapour. When humidity in air is equal to its capacity, it is known as saturated air. Cold air has less capacity to hold water vapour in their warm air. See below given figure.

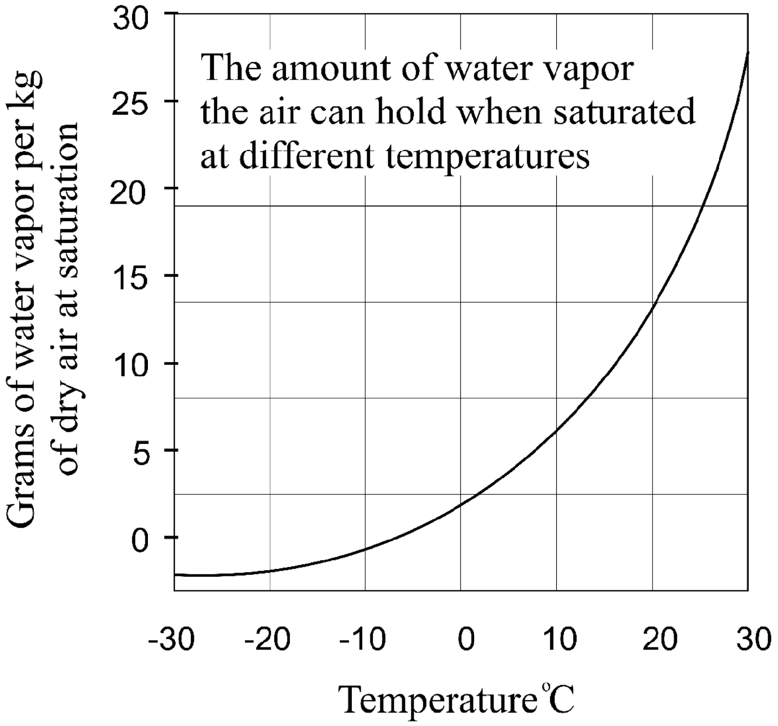


Fig. 8.1 Relation between Temperature and Absolute Humidity

Absolute humidity is a measure of the quantity of water that can be extracted from the atmosphere as precipitation. Cold air can supply only a small quantity of rain or snow whereas warm air is capable of supplying a huge quantity of water.

There is a disadvantage of using absolute humidity, when air rises or sinks in elevation, it undergoes corresponding volume changes like expansion or compression. Thus the absolute humidity cannot remain a constant figure for the same body of air. Modern meteorologists, thus make use of another measure of moisture content specific humidity.

The weight of water vapour per unit weight of air is called specific humidity. The unit of air weight is in kilograms and unit weight of water vapour is in grams. Hot and humid air of Equatorial regions can have 16 to 18 grams water vapour.

B. Relative Humidity

Relative humidity is the most important and reliable measure of atmospheric moisture. It states the relationship between the absolute humidity and the maximum capacity of the air to hold moisture at the same temperature.

This ratio between the actual humidity of air and its maximum capacity to hold moisture at a given temperature is known as Relative Humidity. It is always expressed in percentage. It can best be understood with the help of a simple formula.

$$\textit{Relative Humidity} \quad \frac{\textit{Absolute humidity(Actual amount of water vapour present in the air at a given temp}}{\textit{Humidity relative capacity (Amount of water vapour that can be held by the same air at the same temperature)}}$$

It is quite clear that air can hold a definite maximum quantity of water vapour at a given temperature. When this situation is attained, the air becomes fully saturated. The temperature at which a given sample of air becomes fully saturated is called the dew point or saturation point. The relative humidity of an air of saturation point is hundred percent. To make it clearer, let us take an example. An example considers at a given time, the temperature of the air is 21°C and the total amount of water vapour present is 11.1 grams. Whereas its retentive capacity is 22.2 gms. Relative humidity will be:

$$\text{Relative humidity} \quad \frac{\textit{Absolute humidity 11.1 gms}}{\textit{Retentive Capacity 22.2 gms}} \times 100 = 50\%$$

If the same air is holding 22.2 gms. of water vapour at the same temperature, the relative humidity will be 100 percent.

The relative humidity increases when the temperature of the air goes down or when more moist air is added to it. The relative humidity decreases when the temperature of the air increases or when less moist air is added to it.

- Absolute humidity is the actual amount of water vapour present in grams per cubic metres of a given air.
- Relative humidity is the ratio of actual water vapour content to the maximum moisture holding capacity of an air at a given temperature and it is expressed in percentage (RH=AH/Max. capacity × 100).
- The weight of water vapour per unit of air is called specific humidity. The unit of air weight is in kilograms and unit weight of water vapour is in grams.
- The temperature at which a given sample of air becomes fully saturated is called 'dew point' or 'saturation point'.

	Absolute Humidity	Relative humidity
1.	It helps us to know the actual amount of water vapour present in air	It shows the ratio of water vapour actually present in the air at a given temp. to the retentive capacity of humidity of the same parcel of air at the same temp.
2.	It does not take temp. into account	It takes temp. into account
3.	It is expressed in grams per cubic metre	It is expressed in percentage
4.	It is not useful measure of humidity because it does not fell us the amount of water vapour required for the air to become saturated	It is a useful measure of humidity because it can show how humidfor the air isis humid.

Changes in the relative humidity of Air

Change in Relative Humidity can occur in the following three ways:

1. The temperature remains the same and the amount of water vapour in the airin air increases. Its relative humidity will also increase.

2. When the temperature of air rises, its water vapour retentive capacity also rises correspondingly, the relative humidity decreases.

3. If the temperature of air decreases, its water vapour retentive capacity also decreases and relative humidity decreases.

The humidity of air determines the amount and rate of evaporation. It is why humidity is an important element of climate.

Effects of humidity

1. High relative humidity causes irritation to human beings because perspiration does not dry easily.

2. In the case of low relative humidity, skin becomes dry. Cracks begin to appear on the skin.

3. On account of rise in relative humidity patients suffering from trouble in joints feel pain.

INTEXT QUESTIONS 8.1

1. Fill in the blanks with appropriate word -

   (a) _______________ is very important among elements of weather.

   (b) The temperature at which the air becomes fully saturated is called ___________.

   (c) The relative humidity of saturated air is ____________________ percent.

2. Give a geographical term for each of the following;

   (a) The amount of water vapour actually present in the atmosphere.

   ____

   (b) The air that contains moisture to its full capacity is called

   ____

   (c) Amount of invisible water vapour present in atmosphere is generally termed as

   ____

   (d) The temperature at which a sample of air becomes saturated.

   ____

   (e) The weight of water vapour per unit of air is termed as _______________________

   ____

8.3 EVAPORATION

The evaporation is the physical process by which a liquid like water is transformed into a gaseous form. This process takes place at all places, at all times and at all temperatures excepts at dew point or when the air is saturated. It is important to note that about 600 calories of heat is used for converting each gram of water into water vapour (calorie is a unit of amount to energy). To raise the temperature of 1 gram of water through 1°C, one calorie of energy is required. At the time of evaporation, heat is absorbed and conserved in water vapour. It is known as latent heat. It is a sort of hidden heat. The latent heat consumed in changing water into gaseous form is released when water vapour changes into water or ice. The release of latent heat in the air is an important source of energy for causing the development of storms, cyclones or typhoons. A loss of water from leaf and stem tissues of growing vegetation is called transpiration. The combined losses of moisture by evaporation and transpiration from given areas are termed as evapo-transpiration.

The rate of evaporation is affected by several factors. Some important factors are given below: -

1. **Accessibility of water bodies-** the rate of evaporation is higher over the oceans than on the continents.

2. **Temperature -** Due to higher temperature in summers, the rate of evaporation is more in summers than in winter. That is why wet clothes dry faster in summers than in winters.

3. **Air moisture -** Aridity or dryness of the air also increases the rate of evaporation. During rainy days, wet clothes take more time to dry owing to the high percentage of moisture content in the air than on dry days.

4. **Cloud cover -** The cloud cover prevents solar radiation and thus influences the air temperatures at a place. This way, it indirectly controls the process of evaporation.

5. **Wind -** Winds induce a higher rate of evaporation. Winds blow away humid air and dry winds take over their place. Dry winds cause rapid evaporation.

    - The evaporation is the process of charging water into water vapour.
    - The rate of evaporations is affected by the accessibility of water, temperature, aridity of air, wind and cloud cover.
    - The heat energy used for changing the state of water or liquid to gaseous state or from solid to liquid state without changing its temperature is called latent heat.

8.4 CONDENSATION

The process of condensation is the reverse of evaporation. In this process a gaseous substance changes its state into liquid or solid state. When the temperature of saturated air falls below the dew point, the air becomes incapable of holding its entire moisture content in vapour form. The excess of moisture is then released into liquid state, and if the temperature is sufficiently low, the release can be in solid state. This change of the state of moisture from invisible water vapour to visible liquid (water) or solid (ice or snow) state is known as condensation.

Condensation always takes place around some particles present in air. These may be dust particles, smoke, oceanic salt or carbon dioxide which act as a nuclei to hold water. They are thus called hydroscopic nuclei.

The process of condensation is directly related to the relative humidity and the rate of cooling. The most favourable condition for condensation is on account of fall in temperature of air. When the humid air faces an obstruction like a hill, it rises. On rising its temperature further decreases and the process of condensation begins to operate.

Notes

- Condensation is a process of changing water vapour in tiny droplets of water or ice crystals.
- Condensation takes place when temperature of air falls below dew point and is controlled by relative humidity of the air and rate of cooling.

Forms of condensation

The forms of condensation may be classified into two groups on the basis of place where it is occurring.

On the ground or on natural objects such as leaves of plants or trees and grass	In the air at some height in the troposphere.
Dew, frost, fog, mist, smog	Clouds

Condensation may also take place according to temperature

When the dew point is below freezing point or below 0°c	When it is above freezing point
Frost, snow and cirrus clouds	Dew, mist, fog, smog and some clouds are formed

A DEW

The tiny drops of Water found early morning on the blades of grass, on the leaves of small plants and trees are called dew. It is formed on account of condensation of moisture in the atmosphere on or near the ground surface. Some favourable conditions for the formation of dew are the following.

1. **Long Nights -** During long nights earth's surface is cooled. When humid air comescome into contact with thethe contact with cold surface, condensation occurs in the form of dew.
2. **Cloudless clear sky -** When there is clear sky, little or no wind, high relative humidity and cold long nights condensation occurs in the form of dew. These conditions lead to greater terrestrial radiation and the solid objects become cold enough to bring the temperature of air down below dew point. In this process extra moisture of the air gets deposited on various objects or surfaces.
3. **Relative humidity -** High relative humidity promotes more condensation and dew formation. Therefore dew can be found more in the months of August - September in India.

4. **Dew point -** Dew point being higher than freezing point, promotes dew formation and conversely frost is formed.

B. Frost

When the dew point is below freezing point, the condensation of extra moisture takes place in the form of very minute particles of ice crystals. It is called frost. This form of condensation is disastrous for standing crops, such as potato, peas, pulses, grams. Generally the conditions of formation of dew and frost are the same. Only temperature should fall below freezing point for the formation of frost.

C. Fog

Fog comprises a dense mass of small water drops or smoke or dust particles in the lower layers of the atmosphere. Fog results from the cooling of air below its dew point; cooling is caused by radiation, conduction and mixing of warm and cold air masses.

Three types of fog have been identified. These are as follows -

(a) Radiation Fog - It is the commonest type of fog. It needs the following for its formations - (i) An should have been under a cloud cover with rain falling a day before (ii) Pools of air, cooled to an excessive degree (iii) cloudless sky on the night before.

(b) Advection fog is formed through the transportation of warm, moist air over cold surfaces. This type of fog occurs along the sea coasts and shores of large inland water bodies.

(c) Frontal fog is formed along the front separating cold and warm air masses. Cooling is caused by the forced ascent of air due to convergence. Frontal fogs are commonin the cool temperate belt where fronts are frequent.

D. Mist

Mist is a type of fog in which the visibility is more than 1000 metres but less than 2000 metres. It becomes foggy when the visibility is less than 1000 metres.

E. Smog

Smog is a fog that has been polluted by smoke, dust, carbon monoxide, sulpher dioxide and other poisonous wastes smog frequently occurs in large cities and industrial centres. In 1952 smog caused deaths of over 4000 people in London.

F. Clouds

As against fog clouds are formed at considerable height above the ground in the atmosphere. Condensation is the common cause of formation of clouds. Moist air gets cooled after reaching considerable height. Water vapour isare changed into tiny droplets of water or snow crystals, when these droplets a crystal rise up or travel across the sky close together, they are called clouds.

The clouds change their shape and appearance almost every second. Sunlight also affects their appearance. Therefore clouds are seen in different sizes. To facilitate classification of clouds, some important types are given below -

(a) Cirrus cloud - being at considerable height these clouds are formed of ice crystals. They look like fan -shaped and are rightly called cirrus clouds.

(b) Cumulus clouds - with a flat base, they look like domes at the top. In appearance, they look like a cauliflower.

(c) Stratus Clouds - They appear like sheets in layers and cover the whole or large parts of the sky.

- Dew, fog, frost, mist, smog and clouds are forms of condensation.
- Frost and some clouds are formed when condensation take place below freezing point
- Clouds are grouped into three types on the basis of their appearance.

INTEXT QUESTIONS 8.2

1. Write geographical term for each of the following -

(a) Physical process in which liquid like water transformed into vapour or gaseous state ___________

(b) At the time of evaporation, heat is absorbed and conserved in water vapour. It is known as __________.

(c) The process of change of water vapour into liquid or solid state _________________

(d) Condensation always takes place around some particles that are known as _________.

Notes

2. Name three types of fog.

   (i) ______________________________

   (ii) ______________________________

   (iii) ______________________________

3. List any three factors which affect the rate of evaporation.

   (i) ______________________________

   (ii) ______________________________

   (iii) ______________________________

8.5 PRECIPITATION

The falling of water droplets, ice crystals and other forms on the ground is called precipitation. It includes drizzle, rain, cloud burst, snow fall, sleet and hail.

When water vapour rises up in the atmosphere, condensation takes place and the tiny droplets and ice crystals form the clouds. These tiny droplets in the cloud ascend further and under certain favourable conditions join together and become bigger and heavy. When they are unable to remain suspended in the atmosphere, these fall on the ground in the form of precipitation.

Forms of Precipitations

A. **Drizzle -** The light rain falling in very tiny drops is called drizzle. These droplets are tiny particles of less than 05 mm diameter. They are so tiny and light that even the light wind may blow them away.

B. **Rain -** Rainfall is in the form of drops of water. These drips may vary in diameter from 0.5mm to 7 mm. Sudden and violent rainfall is termed as a shower. The shower drops are large and heavy.

C. **Snowfall -** When condensation takes place below freezing point, the water vapour changes into tiny ice crystals. These tiny ice crystals grow in size and form the flakes which become big and heavy and start falling on the ground. This form of precipitation is called snowfall. Snowfall is very common in western Himalayas and mid and high altitude regions in winter.

D. **SLEET -** Sleet is frozen rain, formed when rain before falling on the ground passes through a cold layer of air and freezes. The result is the creation of solid particles of clear ice. It is usually a combination of small ice balls and rime.

E. **HAIL -** The precipitation in the form of hard solidified pellets of ice is known as hail. These pellets may be rounded and small sized like those of peas. The small ice granules may also grow in size and their structure resembles that of an onion and may grow to the size of a tennis ball. In this case bigger granules have frozen layered structure. The bigger granules cause great harm to standing crops. In India, during the months of March to May hail storms are common.

- Falling down of atmospheric moisture on the Earth's surface is called Precipitation.
- The precipitation in the form of tiny droplets of water and bigger water droplets are known as drizzle and rainfall respectively.
- When the precipitation is in the form of big ice balls, it is called snowfall.

When a mass of moist air ascends to altitude it cools down. In doing so, it attains dew point which leads to condensation and ultimately precipitation. Thus the cooling of air occurs mainly when it rises. There are three important ways in which a mass of air can be forced to rise and each of these ways produces its own characteristic precipitation or rainfall.

Based on the ascend of air, rainfall is classified into three types -

1. **Convectional Rainfall -** Excessive heating of the earth's surface in tropical regions results in the vertical convectional currents. These currents lift the warm moist air to higher strata of the atmosphere. When the temperature of such humid air starts falling below dew point continuously, clouds are formed. These clouds cause heavy rainfall associated with lightning and thunder. This type of rainfall is known as convectional rainfall. It is very common in equatorial regions where it is a daily phenomenon in the afternoon at 4 pm throughout the year. For this reason it is also called 4' o'clock rainfall.

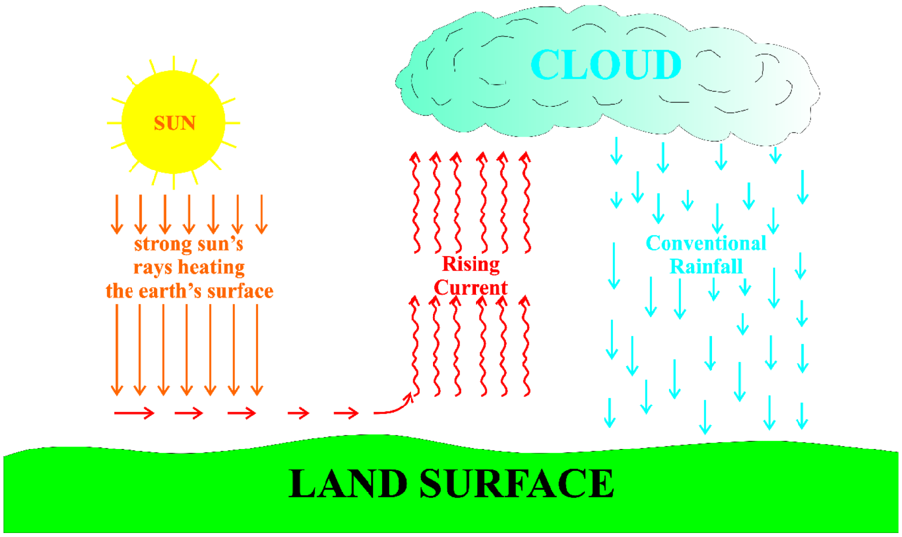


Fig - 8.2 Diagram of convectional rainfall

Notes

ii. **Orographic Rainfall -** It may also be called as relief rainfall. It is caused when air is forced to rise up a hill, mountain or hilly plateau. The winds facing the direction of the mountain range ascend and are cooled upon gaining a certain height. On reaching the saturation point condensation starts, and on further cooling rainfall begins. The special feature of the areas of high relief is that the windward side receives more rainfall than the leeward side because the winds shed most of their moisture before crossing the barrier. Not only this while descending on the seaward of the mountain the winds are further warmed and their capacity to hold moisture rises. As a result there is either less or no rainfall. For example Mahabalshwar lying on the windward side of western Ghats receives annual rainfall of about 622 cms against Pune on the leeward side only 70 km. away from Mahabaleshwar receive only 66 cms annual rainfall.

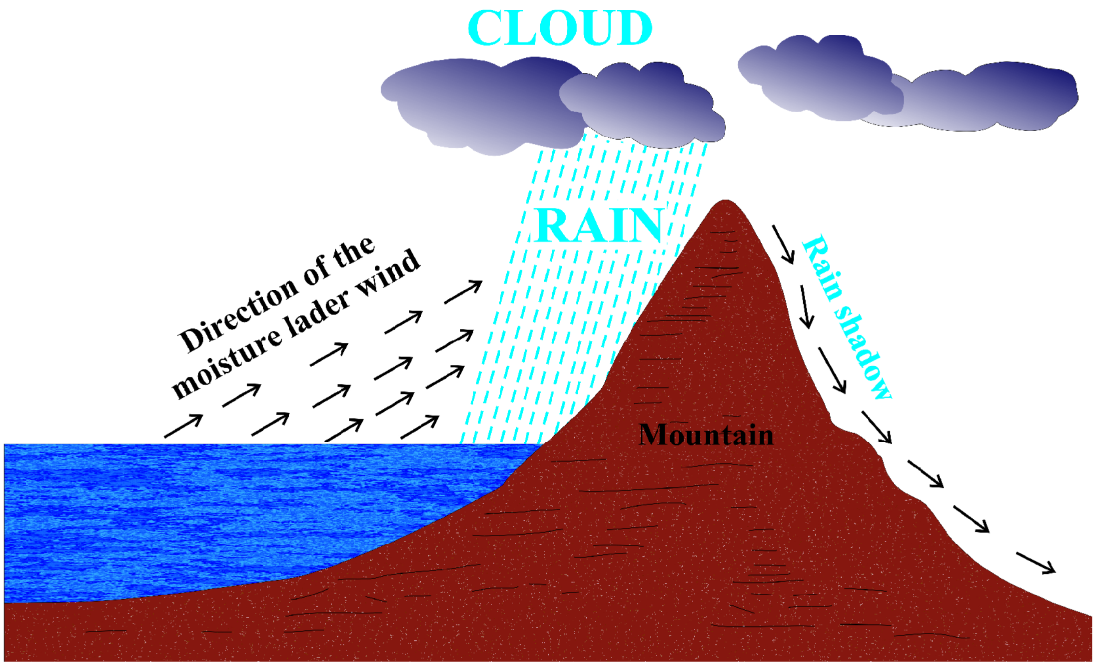


Fig. 8.3 Diagram of Orographic Rainfall

iii. **Cyclonic Rainfall-** When a warm air mass converges with a cold air mass stormy conditions are created. Being lighter, warmlighter warm air mass rises above the cold air mass. The humid and warm air upon ascent is cooled. On becoming cooler below the saturation point condensation takes place and clouds are formed. These clouds are rain bearing cumulus clouds and give heavy rainfall. This type of rainfall is generally received in mid latitudes where comparatively warm westerly humid winds converge with dry polar winds.

It is on account of this convergence, cyclonic or convergence precipitation occurs in these areas. In cyclonic rainfall air from all sides rushes towards the centre and it then forced to rise upward. On ascent, it cools and the process of condensations begins to

cause rainfall. The path followed by cyclones gettingget heavy to moderate rainfall on the eastern coasts of India isare its bestit s best example.

8.6 DISTRIBUTION OF PRECIPITATION

The spatial distribution of precipitation is not uniform all over the world. The average annual precipitation of the world is 97.5 cms. but the landmass receives areceive lesser amount of rainfall than the oceans. The annual precipitation shows marked difference In the land. Different places of the earth's surface receive different amount of annual precipitators and that too in different seasons. Somewhere it rains torrentially throughout the year, at other places it rains occasionally and those two are very scanty like in deserts. There is a place in the Atacama desert in Chile where no rainfall was received for four years continuously. On the other side Mansynram in Meghalaya is the wettest place on earth. It received 26000 mm (1000 inches) of rainfall in 1985.

The main features of the distribution of precipitation can be explained with the help of global pressure and wind belts, distribution of land and water bodies and the nature of relief features - Now let us first see regional distribution of precipitation

A. Regional Variations

On the basis of average amount of annual precipitation, the following four precipitation regions can be recognized.

(i) **Region of Heavy Precipitation : -** The regions which received more than 200 cms of rainfall are included in this category. Equatorial coastal areas of tropical zone and west coastal regions at temperate zone are included in this category.

(ii) **Regions of moderate Precipitation :-** The regions receiving 100 to 200 cms. of rainfall are included in this category. Eastern coastal regions of sub-tropical zone and coastal regions of the warm temperate zonegone are included in the category.

(iii) **Regions of less Precipitation :-** These regions tie in the interior parts of the tropical zone and eastern interior parts of temperate zone and receive precipitation between 50 to 100 cms of.

(iv) The areas lying in the leeward side (rain shadow areas) of the mountain range, in interior parts of continents, western margins of continents receive less than 50 cm precipitation.

B. Seasonal Variations

The regional variations in the distribution of precipitation do not give the correct picture of the nature of precipitation in such regions where seasonal fluctuations in the amount

Notes

of precipitation are very common. Therefore it is important to study seasonal variations of precipitation in the world.

Seasonal distribution of precipitation provides us an idea to judge its effectiveness. For example the scanty precipitation during short growing season in high latitudes is more effective than that of heavy precipitation in lower latitudes, precipitation in form of dew, fog and mist in some parts like Central India and Kalahari desert has an appreciable effect on standing crops and natural vegetations.

C. Factors affecting Rainfall Distributions-

(i) Moisture supply- to the atmosphere is the main factor in determining the amount of rainfall in any region.

(ii) Wind direction - winds blowing from sea to land cause rainfall while bearing lands are dry.

(iii) Ocean Currents - Warm currents help in causing rainfall while cold currents cause no rainfall.

(iv) Preserving mountains across the directions of winds causes more rainfall on the windward side and creates rain shadow on the leeward side.

(v) Pressure belts are closely related with wind direction and rainfall.

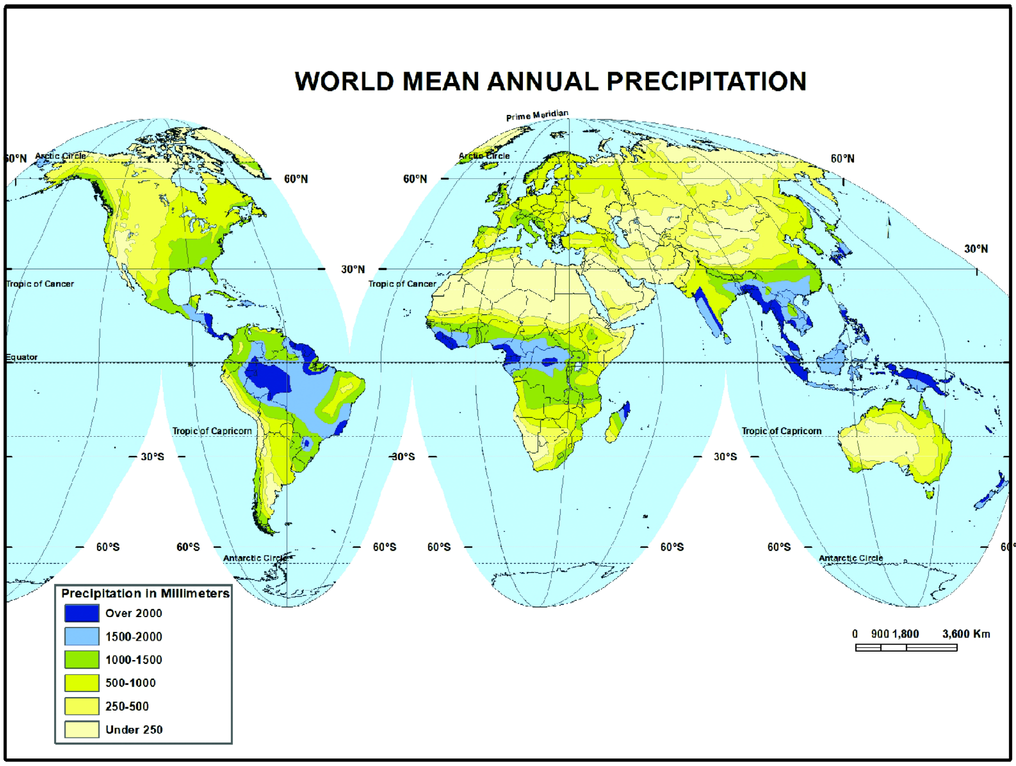


Fig 8.4 Distribution of mean precipitations in the world

INTEXT QUESTIONS 8.3

1. Give a geographical term for each of the following.

   (a) The process in which water vapour is changed into water ______________.

   (b) Leeward side of the mountains or hill receive less rainfall ________________.

   (c) The Ascent of humid and warm air and its contact with colder air results in ____________.

   (d) The light rain falling in very tiny drops is called_________________________.

2. List any four forms of Precipitation.

   (a) ______________________ (b) ______________________

   c) ______________________ (d) ______________________

3. Name three types of rainfall.

   (a) ______________________ (b) ______________________

   c) ______________________ (d) ______________________

WHAT YOU HAVE LEARNT

- Water vapour is an important element of the atmosphere. It is responsible for global heat balance, atmospheric phenomena and sustaining plant, animal and human life and earth.
- The water vapour present in the atmosphere is called humidity which can be expressed in two ways - absolute humidity and relative humidity.
- Relative humidity is the most reliable measure for forecasting weather.
- Water vapour enters into the atmosphere through a process called evaporation.
- Temperature of the air controls the capacity of holding moisture at a given volume.
- The air which holds the moisture to its full capacity is called saturated air and the temperature at which it reaches saturation point is called dew point.
- Condensation is a process of changing of water vapour into liquid or solid state. It happens where the temperature of an air falls below dew point condensation occurs

near the ground as dew, mist of fog and at higher levels of clouds.

- Falling down of atmospheric moisture is called precipitation. Drizzle, rainfall, snowfall, sleet and hail are various forms of precipitation.
- There are three ways in which rainfall occurs - convectional, orographic and cyclonic.
- The spatial distribution of precipitation is not uniform all over the world. The landmass receives less rainfall than oceans.

TERMINAL QUESTIONS

1. Explain the importance of water vapour in the atmosphere.
2. Define, humidity
3. On which factors does evaporation and its rate depend?
4. When and how does condensation take place?
5. Explain forms of condensation.
6. Condensation begins only after saturation of air elaborate this statement.
7. Distinguish between each of the following -
8. "With changes in temperature relative humidity also changes". Explain the statement.

9 Describe any five factors affecting rainfall distribution.

ANSWERS TO INTEXT QUESTIONS

8.1

1. (a) humidity (b) dew point
   (c) 100 percent
2. (a) Absolute humidity
   (b) Saturated air (c) humidity
   (d) dew point (e) specific humidity

8.2

1. (a) Evaporation (b) Latent heat

   (c) Condensation (d) Nuclear

2. (i) Radiation fog

   (ii) Advection fog

   (iii) Frontal fog

3. (i) Accessibility

   (ii) Temperature

   (iii) Air moisture

   (iv) Wind

   (v) Cloud cover (any three)

8.3

1. (a) condensation

   (b) less rainfall

   (c) cyclonic rainfall

   (d) drizzle

2. (a) Drizzle

   (b) Rain

   (c) Snowfall

   (d) Sleet

   (e) Hail

3 (a) Convectional

   (b) Orographic or Relief rainfall

   (c) Frontal or cyclonic rainfall

9

CLIMATE AND CLIMATE CHANGE

In the previous lessons, you have studied the dynamics of the atmosphere with special reference to its structure and composition, insolation, air pressure, winds, humidity and precipitation. These climatic elements have a significant effect on our existence. For instance, the houses we build, the garments we wear, and the food we consume largely depend on the climatic conditions. In this lesson, you will learn about the climate, major climate regions, climate change - causes and consequences and global initiatives to mitigate the effects of climate change. Climate and weather are sometimes used interchangeably but they are conceptually quite different. Therefore, to understand climate, it is very essential to comprehend the meaning of weather.

OUTCOMES

After studying this lesson, learner:

- differentiates between weather and climate;
- describes various climate regions;
- explains the concept of climatic change;
- identifies the causes and consequences of climate change and
- describes major global initiatives - related to climate change;

9.1 WEATHER AND CLIMATE

As you know, the blanket of air which surrounds Earth is called atmosphere. Earth's atmosphere is very dynamic and continually changing on a daily basis in terms of temperature, pressure, wind, humidity and precipitation. You are aware that there is an inverse relationship that exists between temperature and pressure; pressure and wind. For example, the area experiencing

Notes

high temperature will have low air pressure and consequently strong wind prevails and vice versa. In addition to that, temperature, pressure and wind affect precipitation, humidity, sunshine, cloudiness and other atmospheric conditions. Therefore, all these atmospheric elements are interconnected and influence the atmospheric conditions of a place. These conditions differ from place to place and time to time.

High Temperature → Low Pressure → Strong Wind

Temperature → Pressure → Wind

Low Temperature → High Pressure → Calm Wind

Fig. 9.1. Relationship among the Weather Elements

a. Difference between Weather and Climate

Climate and weather are sometimes used as synonyms but they are not the same (Table 1). The state of general atmospheric conditions with respect to temperature and pressure is called weather. An important characteristic of weather is it changes every day and can be erratic.That is why we get daily weather updates and alerts. The meteorological agencies like Indian Meteorological Department (IMD) provide weather forecasts. On the other hand, climate refers to the long-term averaged weather conditions of a particular area or region. According to the World Meteorological Organisation (WMO), the average of the weather conditions is calculated from the data collected over the period of 30 years.

Table 9.1.Difference between Weather and Climate

Criteria	**Weather**	**Climate**
Definition	Daily changes in the atmospheric conditions is called weather	Averaged weather conditions of a particular regions is called climate
Period of time	Short period -24 hrs	Long period - more than 30 years
Elements	Temperature, air pressure, wind, precipitation, humidity, sunshine, cloudiness	Average temperature, average pressure conditions, average wind velocity etc
Areal Extent	Small area/Local	Large area/Global
Change	Very frequently	Largely permanent
Types	Different types of weather conditions prevail in a day	Broadly one type of climate is experienced in an area

b. Factors Affecting Climate

There are various types of climate on the basis of elements for example, hot or cold (with reference to temperature), dry or wet (amount of rainfall), arid or humid (humidity or moisture content). Different regions of the world experience different types of climate and influence human activities. To understand the variation in climates, let us discuss the factors which cause the variation in the climate of a particular region.The climate of an area is determined by various factors. These factors are as follows:

i. **Distance from the equator or Latitude:** The climate of an area is influenced by the distance from the equator. The places located near the equator are warmer than the places located away from it. The reason, you have already learnt in lesson 5, is insolation. Equatorial areas receive more heat as intense vertical sun rays fall on a small area whereas Temperate and Polar Regions receive slant rays which are less intense. Maldives is located near the equator which experiences a hot climate whereas Switzerland is situated far away and has a cold climate.

ii. **Elevation:** Highlands are cooler than the lowlands. As we move upwards from the sea level, temperature decreases. The lapse rate is 1 decreases with every 100 metres. Leh is situated at a higher altitude when compared to Jaisalmer. Therefore, Leh is cooler than Jaisalmer.

iii. **Global Winds and Ocean Currents:** Global winds are also known as prevailing winds. They are the result of atmospheric circulation cells and pressure belts. Upwards and downwards movement of air causes precipitation. Besides that, onshore winds are moisture-laden as they come from sea or ocean therefore bring rain, whereas off-shore winds originate from land and they are dry.

Another characteristic of prevailing winds is that they bring air from one type of climate to another. For example, warm winds that travel over water are moisture-laden, the water vapour in the air will condense as it moves into cooler climates and temperature coastal regions receive heavy rainfall.

Surface ocean currents are driven by a global wind system.Their pattern is determined by the wind direction, Coriolis force and position of landforms. The warm current raises the temperature of the coast and may bring rainfall while the cold current reduces the temperature and creates fog and mist.

Due to the rotation of the earth, circulation of winds is deflected towards the right in the northern hemisphere and left towards the southern hemisphere. This defection is called CoriolisEffect.

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iv. **Geographic Character:** Geographic character of an area encompasses the locational aspect such as distance from the sea or ocean, direction of mountains etc. As you know, the sea has a moderating effect. The places near large water-bodies have a low range of temperature and very high humidity. The places which are away from the oceans experience extreme temperature as they are away from water-bodies.

Direction of mountains is another factor which affects the climate of a region by influencing the direction of moist winds to rise and cause rainfall on the windward side. And when they descend on the leeward side they become dry and cause less rainfall.For example, the places located on the windward side of Western Ghats like Mumbai receive more rainfall as compared to Nagpur, which is located on the leeward side.

v. **Vegetation:** Climate produces forest, desert and so on. Temperature and rainfall patterns decide the characteristics of the soil formation and eventually affect the type of vegetation. Stony or sandy soils are good conductors of heat while black clay soil absorbs heat quickly. The areas which lack vegetation like deserts are hot during the day time and cold at night. On the other hand, forested areas have a lesser range of temperature throughout the year.

vi. **Other Factors:** There are various other climate controlling factors which have been highlighted in following Table.

Table 9.2: Climate Controlling Factors

Factors	**Effects**
Land Surface	Albedo Evaporation Temperature
Oceans	Albedo Evaporation Energy transferred from the ocean currents and vertical mixing
GreenHouse Gases	Co_2, O_2
Solar Radiations	Orbital controls, Latitude
Clouds	Albedo, Emissivity, Absorption, scattering of solar radiation
Aerosols	Absorption, Scattering of solar radiation, Condensation nuclei

INTEXT QUESTIONS 9.1

1. Write True against the correct statement and write False against the wrong statement.

   (i) Weather provides average atmospheric conditions of a particular area.

   (ii) Area located near equator experience low temperature

   (iii) Warm ocean currents increases the temperature of the coast

   (iv) The lower the elevation higher is the temperature.

9.2 CLIMATIC REGIONS

An area which has homogenous climatic characteristics and has geographic continuity is known as climate regions. To create similar types of climate regions, various attempts have been made by the scholars but there is no single perfect classification available. It is believed that Greek philosopher, Aristotle, probably made the first attempt to classify Earth's climate on the basis of insolation. He divided the world into three thermal zones viz. torrid zone, temperate zone and frigid zone.

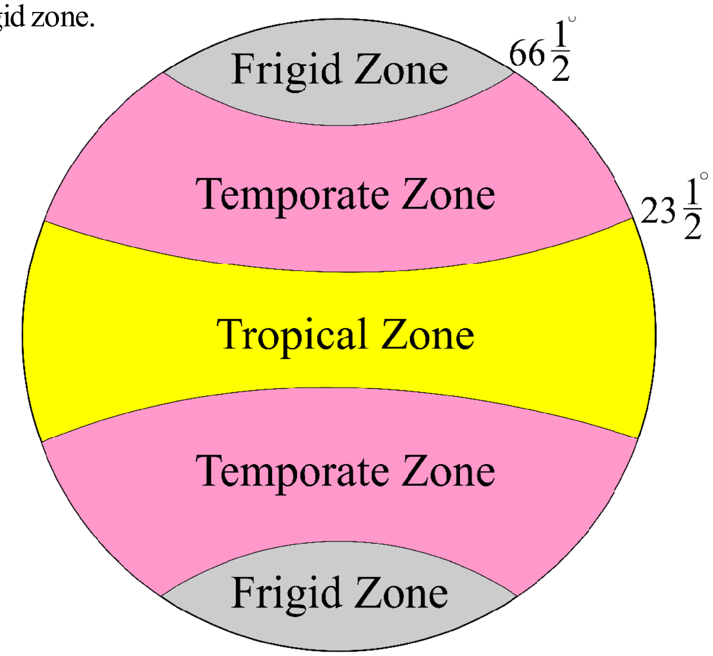

Fig 9.2: Thermal Zones of the World

a. Koppen's Classification of Climate

The most widely used empirical classification of climate was developed by Waldimir Koppen. He identified a close relationship between climate and vegetation and believed that vegetation is an indicator of climate type. On the basis of annual and mean monthly

Notes

temperature and precipitation data along with the distribution of vegetation, he divided Earth's climate into five major regions tropical, dry, temperate, cold and polar.

Design of Koppen Classification: He recognised five major climatic regions and designed by four capital English letters- A, C, D, E on the basis of temperature and one, B, on precipitation. These major groups were subdivided and designed by small letters, f, m, w, s based on seasonality of precipitation and temperature characteristic.

Table 9.3: Major Climate Regions of the World by Koppen

	Major Group		Sub-Group	Characteristics	Climate
A	Tropical Hot and Humid Climate	Af	Tropical rainforest	Hot and rainy all seasons	Hot and humid climate
		Am	Tropical Monsoon	Hot; seasonally excessive rainfall	Monsoon Climate
		Aw	Tropical Wet and Dry	Hot; seasonally dry esp. winter	Savanna Climate
B	Dry Climate	BSh	Subtropical Steppe	Semi arid; hot	Hot Steppe Climate
		BWh	Subtropical Desert	Arid; hot	Hot Desert Climate
		BSk	Mid-Latitude Steppe	Semiarid; cool	Cool Steppe Climate
		BWk	Mid-Latitude Desert	Arid; cool	Cool Desert Climate
C	Warm Temperate Climate	Cs	Mediterranean	Mild winter; summer dry	Mediterranean Climate
		Cw	China Type	Mild winter; winter dry	China Type Climate
		Cf	Europe	Mild winter; moist all seasons	Europe Climate

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D	Cold Snow Forest Climate	Df	Humid continental	No dry season; severe winter	Taiga Climate
		Dw	Subarctic	Winder dry and very severe	Continental Climate
E	Polar Climates	Et	Tundra	Very short summer	Tundra
		Ef	Polar ice cap	Perpetual ice and snow	Polar ice cap
H	Highlands		Highland	Highland with snow cover	Undifferentiated highland climates

b. Climatic Regions of the World

As you are aware, Koppen has provided a climate scheme with the first (Major Group) and second letter symbols. For some regions like B, C and D, he has created third letter symbols as well which has been discussed below. The distribution of climate major groups, sub-groups and its characteristics are presented in Table 9.3 and map highlights the locational aspect. If has been devided five major groups.

(i) Major Group A: Tropical Hot and Humid Climate

(ii) Major Group B: Dry Climate

(iii) Major Group C: Warm Temperate Climate

(iv) Major Group D: Cold Snow Forest Climate

(v) Major Group E: Polar Climate

i. **Group A Climate:** The tropical hot and humid climate is characterised with high temperature (>18°C) and high rainfall (6 cms) throughout the year. On the basis of seasonality and periodicity of rainfall, it has been further subdivided into Af, Aw and Am.

ii. **Group B Climate:** Dry climate is signified with low precipitation and high rate of evaporation. The region is further classified into BW and BS. On the basis of annual temperature, it has been further subdivided into-

BWh = Tropical hot desert with mean annual temperature >18°C

BSh = Tropical steppe climate with average annual temperature >18°C

BWk = Moderate latitude cold desert climate with mean annual temperature <18°C

BSk = Moderate latitude cold steppe climate with average annual temperature <18°C

iii. **Group C Climate:** Warm Temperate Rainy climate is characterised with precipitation throughout the year with mean temperature ranging between 3°C to 13°C. On the basis of seasonality of rainfall, the region further categorised into-

Cf = Precipitation > 1.2" throughout the year. This category has three second order sub-classes namely Cfa (Humid subtropical), Cfb (marine west coast type) and Cfc (marine type with short cool summers)

Cw = Winters are mild and dry. Its second order classes are Cwa (Subtropical monsoon) and Cwb (Tropical Upland)

Cs = Winters are wet but summers are dry, precipitation < 1.2". The second order sub-categories are Csa (Interior Mediterranean) and Csb (Coastal Mediterranean).

iv. **Group D Climate:** In the cold snow frost climate, average temperature varies between 0°C to > 10°C. This type of climate has been further classed into Df and Dw. The second order sub-regions are:

Df = Humid cold climate with no dry season

Dfa = Humid continental with long warm summer

Dfb = Humid continental with short warm summer

Dfc = Sub-arctic with humid short cool summer

Dfd = Sub-arctic with humid extremely cold winters

Dw = Humid cold with dry winters

Dwa = Humid Continental climate with long hot summers

Dwb = Humid Continental warm summer

Dwc = Sub-arctic short cool summers

Dwd = Sub-arctic extremely cold winters and short cool summers

v. **Group E Climate:** The region is featured with very cold conditions in which average temperature is <10°C. The second order classes are as follow

ET = Tundra climate ranging between 0°C to 10°C

EF = Permanent snow field temperature <0°C.

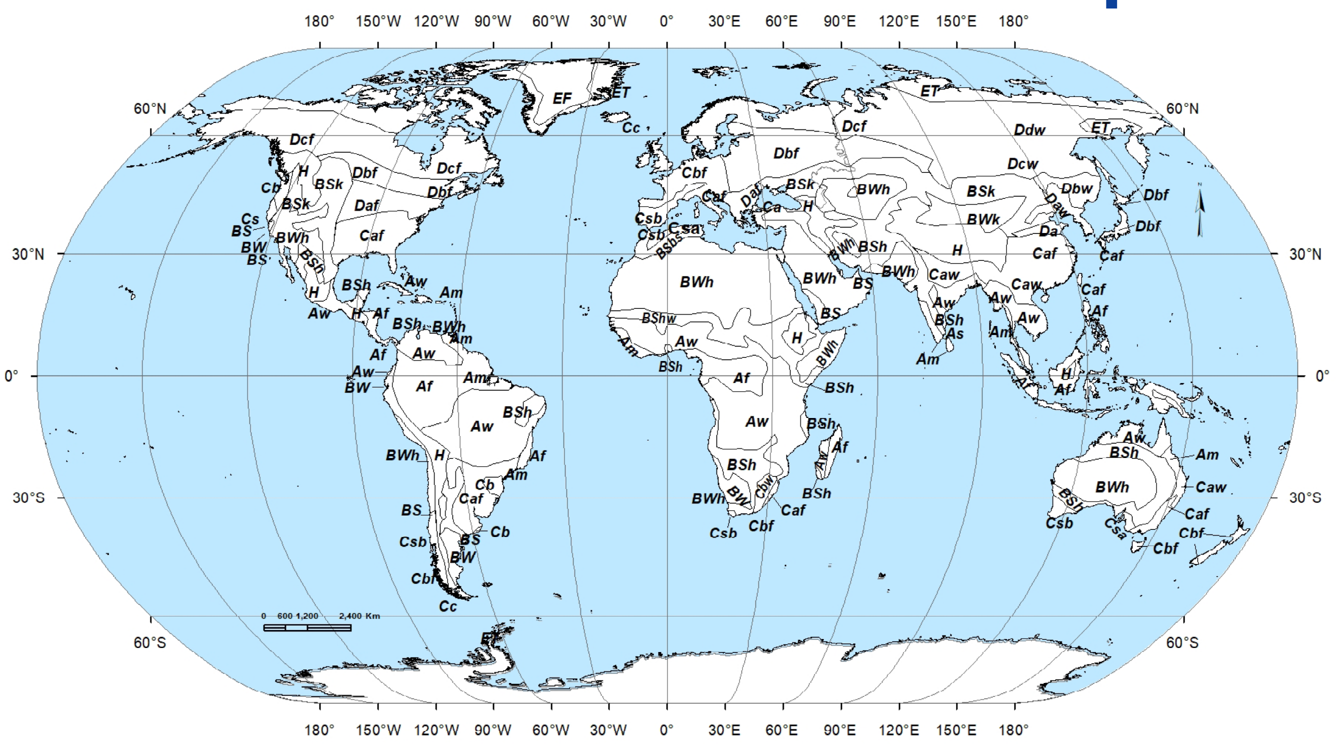


Fig. 9.3 Koppen's Climatic Classification

INTEXT QUESTIONS 9.2

1. Multiple Choice Questions

   i. Koppen identified how many major climatic regions of the world:

   (a) 6 b) 4

   (c) 5 (d) 7

   ii. Climate classification of Koppen is considered as

   (a) Applied

   (b) Empirical

   (c) systematic

   d) Generic

   iii. Greeks divided the world climate into how many thermal zones

   (a) 3 (b) 4

   (c) 5 (d) 6

iv. Major climate group "C" refers to:

(a) Tropical hot and humid climate

(b) Dry Climate

(c) Warm Temperate Climate

(d) Polar

9.3 CLIMATE CHANGE

In the previous sections, you got some understanding about the present climatic regions. Largely, the type of climate we experience might have prevailed thousands of years ago with mild changes. The earth has observed various changes in the climate since its evolution. Geological and historical records prove that climate change is not a new phenomenon; instead, it's natural and continuous. Geological records with reference to glacial and interglacial periods provide traces of advance and retreat of glaciers in the highlands. On the other hand, historical records especially documents signify that earth experiences dry and wet periods.

Currently, the climate of all the regions of the world is changing drastically. Therefore, climate change is a global phenomenon which refers to significant variations in the statistics of averaged weather conditions over a period of time. It has become a serious problem for mankind.

a. Climate Change and Climate Variability

If a person truly wants to understand the concept of climate change then its important to understand climate variability. As you are aware that Earth's climate is dynamic and another significant feature is its variability. Therefore, climate variability refers to anomalies in the existing state of climate which can be observed spatially and temporally. On the other hand, climate change denotes changes in either the average state of climate or in terms of its variability, continuing for several decades or more. The difference between climate variability and climate change is given in Table 9.4.

Table 9.4: Difference between Climate Variability and Climate Change

Climate Variability	**Climate Change**
The fluctuations in the distinct weather events results in climate variability	A mean or average trend of climate variability is known as Climate change
It includes short period of combined form of weather trends	It includes long period of accumulated form of climate variability
It is a micro level or regional phenomenon	It is a macro level or global phenomenon.

Notes

b. Global Warming

Global warming refers to the heating of the whole Earth's air temperature over the past few centuries. This phenomenon occurred due to the presence of greenhouse gases.Greenhouse is a structure in which sun's heat is trapped and used for providing warmth. For example, if you park your car in an open area on a hot sunny day, after sometime you will find that solar energy entered into the car through the door's glass or windscreen and trapped in the car resulting in excessive heating. Similarly, our atmosphere behaves like a greenhouse in the presence of greenhouse gases. The gases that absorb long wave radiation are called greenhouse gases. The whole process that heats the atmosphere is referred to as the greenhouse effect. It increases the temperature of the troposphere.

The major greenhouse gases (GHGs) which help in increasing global warming are carbon dioxide, chlorofluorocarbons, methane, carbon monoxide, ozone and nitrous oxide. The effectiveness of any greenhouse gas depends upon the magnitude of the increase in its concentration, its lifetime in the atmosphere and the wavelength of radiation that it absorbs. Chlorofluorocarbons and ozone are highly effective gases whereas carbon dioxide is largely concentrated in the atmosphere.The level of Co2 is constantly increasing due to burning of fossil fuel and changes in the land use. It is growing at about 0.5 per cent yearly.

Trends of Global Warming: One of the prime problems of the world in the present century is earth's rising temperature or global warming. Now, let us explore to what extent our earth has warmed up. Earth's rapid heating started with the industrial revolution. Since the advent of industrialization, the global annual temperature has risen to more than 1%. From 16880 to 1980, it has increased on an average by 0.07% every decade. Since 1981, the rate of growth in the global temperature has doubled. For the last four decades, it has risen by 0.18% every 10 years. If the trend continues then the global temperature would reach around 1.5% in 2040.

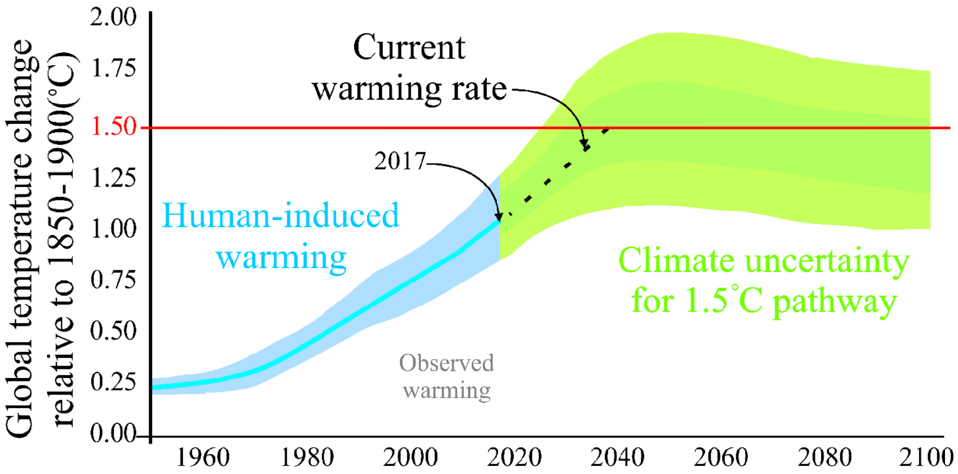


Fig. 9.3: Global Warming (Source: IPCC)

DO YOU KNOW?

Till now, our planet has experienced 9 out of 10 warmest years since 1880.

It is believed that the year 1998 was the warmest in the history of earth's climate.

INTEXT QUESTIONS 9.3

1. Fill in the blanks

   (i) ………..and ……… records prove that climate change is not a new phenomenon, instead it's natural and continuous.

   (ii) …………..is the heating of the whole Earth's air temperature over the past few centuries.

   (iii) Climate change is a ……… phenomenon.

   (iv) The whole process of heating the atmosphere is called the …………..

9.4 CAUSES AND CONSEQUENCES OF CLIMATE CHANGE

As you know, Earth's climate is dynamic and keeps on changing through natural processes. The matter of concern is that the changes that are occurring presently have been exaggerated due to human activities. The causes of climate change can be divided into two categories i.e. natural and man-made.

a. Natural Causes:

i. Continental Drift: Around 200 million years ago, the face of the earth was not the same. There was a large landmass which had drifted apart due to tectonic forces. The drift had an impact on climate as it changed the position of landmass and waterbodies. It resulted in the changes in the flow of ocean currents and winds. Besides that, Himalaya was born out of this phenomenon which shapes the climate of the Indian subcontinent.

ii. Ocean Currents: As you know, ocean absorbs large amount of heat and ocean currents move vast amount of heat across the planet. It has been discussed earlier that how ocean currents influence the climate. The interaction between ocean and atmosphere shapes the climate system and produce El nino Southern Oscillation (ENSO) which occur every 2 to 6 years. The ENSO describes the fluctuations in temperature between ocean and atmosphere, which has two phases El Nino (warm phase) and La Nina (cold phases). The deviation from normal surface temperature

Notes

can have a large impact on ocean processes and global weather processes. Oceans play a significant role in determining the atmospheric concentration of co_2. Changes in the ocean pattern may affect the climate through the movement of co_2 into or out of the atmosphere. Now-a-days, the terms El Nino and ENSO are used interchangeably. El Nino produces severe and extensive changes in climate. Ecuador and northern Peru have arid climates but due to the El Nino affect rainfall has increased drastically. As it brings rain to the region, Indonesia and Australia experience drought.

iii. **Volcanoes:** Massive volcanic eruption changes the climate of the earth, temporarily. The material erupted such as sulphur dioxide, water vapours, ashes and dust reached lower stratosphere,blocked the sun rays and reduced the temperature about 0.5°C.The eruption of Novarupta in 1912 and Mount Pinatubo in 1991 are the example which has affected the climate of earth to some extent.

iv. **Solar Output:** The Sun is the prime source of energy. Global climate is affected by the long and short variation in the intensity of the sun. A smallest change in the intensity can lead to changes in our climate. Scientists demonstrate that solar variations have played a key role in past climate changes. It is believed that a slight decrease in solar movement has caused the little Ice age between 1650 and 1850. But present global warming cannot be described with this phenomenon.

v. **Earth's Orbital Changes:** Earth is tilted at an angle of 23.5 degree to the perpendicular plane of its orbital path. Any change, whether big or small, in the tilt can affect seasons. In other words, we will experience warmer summers and cold winters if the tilt is more and cool summers and mild winters if the tilt is less. The orbital changes lead to Milankovitch cycles. According to IPCC, Milankovitch cycles have a great impact on climate. It is belived that they drove the ice age cycles.

b. Human Induced Causes

The increase in temperature affects other variables of the climate system. Combined effects of human activities on the climate are known as human induced climate change.

There are:

i. **Fossil Fuels:** Climate is a physical phenomenon but anthropogenic factors have altered it immensely. After the advent of the Industrial Revolution, the amount of greenhouse gases in the atmosphere has increased. More greenhouse gases mean more absorption of heat and increase in earth's temperature which will lead to global warming, largely due to burning of fossil fuel like coal and petroleum. Besides that, Industries are exhausting our resources and polluting land, water and air in the

wake of developmental activities. It is estimated that about 20 percent contribution is due to changes in the emission of greenhouse gases.

ii. **Land use Change:** The change in the land use is largely governed by industrialization, urbanisation and cutting of trees for agricultural activities. Deforestation changes the amount of sunlight reflected from the ground back to space, Albedo. In Eurasia and North America, around 50 percent of the land use changes occurred during the industrial period due to replacement of forest with either agricultural or industrial activity.

iii. **Deforestation:** The rainforest plays a vital role in regulating the temperature of the world. These forests absorb one-fifth of human induced carbon emission. Hence, deforestation has been considered as a major contributor to the cause of climate change.The carbon is stored in the form of wood and vegetation through carbon sequestration.

iv. **Agricultural Activities:** According to IPCC, agricultural activities are one of the major drivers of climate change. In order to fulfil human's food demands, more land has been brought under cultivation and animal husbandry. Agricultural activities like animal keeping and rice cultivation have increased the carbon and methane emission. It is believed a quarter of methane emission comes from domesticated animals such as cows, pigs, etc. Moreover, paddy fields also release methane when the field is flooded during the sowing and maturing stage of the crops. Around 90 percent of the rice grows in Asia as a staple crop. Therefore, Asians are considered as a major contributor of climate change.

c. Consequences of Climate Change

Climate change is creating serious threats to the survival of humankind. Every aspect of ecology has been disturbed by human interference. The impacts of climate change are easily visible on water systems (glaciers and sea), agriculture, flora and fauna and human health.

i. **Melting of Glaciers and Ice-caps:** Glaciers and ice-caps are either vanishing or receding especially in the highlands of our planet due to rising atmospheric temperature. Man-made influences have significantly contributed to the retreat of glaciers since 1960's. Earth has lost more than 600 glaciers over the past few decades. They are largely melted in the Greenland, Canadian Arctic, Rocky Mountains, Andes, Patagonia, Himalayas and on various other continents.

ii. **Rising sea level:** The level of sea is rising at an alarming rate due to thermal expansion and the loss of glaciers. The increased concentration of co_2 in the ocean triggered the change and made the water more acidic. Presently, our oceans are

more than 40 percent acidic than it used to be affecting marine life ecally. corals and shellfish. the coral reefs of great Barrier Reef of Australia and Lakshadweep island of India, are facing problems like bleaching and loss of habitat.

iii. **Extreme weather:** Extreme weather events are common phenomena occurring on earth like heat waves, heavy rainfall, intense cyclones, droughts, ice storms, avalanches, dust storms and floods. The frequency and magnitude of these events have also increased due to change in the temperature conditions of the earth. Tropical cyclones have been increasing since the 1970s and causing huge destruction. In India, cyclone Tauktae emerged from Arabian Sea in 2021, killed more than 100 people and was classified as a very severe cyclonic storm.

iv. **Impact on Agriculture:** Agriculture is climate-sensitive and most vulnerable to climate change. As mentioned earlier, it is one of the major cause of climate change and prime source of greenhouse gases.It was predicted by IPCC that higher temperature will reduce crop yield while encourage the growth of weeds and pests.The climate change impact on farm productivity has been divided into two group: a) high and mid-latitude nations and b) low latitude nations. In the former region (North America, Europe, Australia), there is a strong probability that productivity will increase due to extended growing season whereas on the latter region (Africa and Asian countries) farm productivity will decrease.But the overall impact is expected to be negative which will threaten the global food security especially in the less developed countries.

v. **Impact on Flora and Fauna:** The distribution and size of flora and fauna largely depends upon the climate. Climate change can affect both plant and animal species in a number of ways-

- Changes in the climate altering the timing in reproduction and life cycle of plants (budding early) and animals,
- Migration pattern of birds and animals. They have to migrate early.
- Length of growing season of plants.
- Increase the frequency of weeds and pests outbreak.
- Increased the occurrence of diseases and invasive species.
- Altering the range boundaries of flora and fauna: In Europe butterflies have shifted their range 200 kms upwards; moreover, tree lines are also shifting.

vi. **Impact on Health:** Climate change is not only affecting human health but also affecting animals as well. Due to increased temperature and more frequency of

heat waves, it has a direct effect on health. In the summer season, some regions have been experiencing increased heat-related mortalities such as heat stroke, cardiovascular and kidney diseases. The changes in the rainfall and temperature conditions have transformed the distribution of both waterborne and vector diseases like dengue fever, Lyme disease, West Nile virus. On the other hand, in the winter season, climate change has created conditions in some areas with warm and stagnant air eventually forming ground-level ozone or smog. Smog (air pollution) is one of the major reasons for asthma attacks. According to WHO, "Climate change is expected to cause approximately 250,000 additional deaths per year" between 2030 and 2050.

INTEXT QUESTIONS 9.4

1. Match the column

	Climate Change		Impact
(i)	Glaciers	(a)	severe floods
(ii)	Extreme weather event	(b)	affect farm productivity and food security
(iii)	Flora and Fauna	(c)	increased heat-related mortality
(iv)	Agriculture	(d)	recede or vanish
(v)	Health	(e)	alter the timing of reproduction and migration

9.5 GLOBAL INITIATIVES ON CHANGE

International initiatives on climate change are extensive efforts to mitigate the effects of global warming and reduce the emission of greenhouse gases across the globe. The most significant initiatives are the setting up of the Intergovernmental Panel on Climate Change (IPCC) and the Paris Climate Agreement.

a. Intergovernmental Panel on Climate Change (IPCC)

The Intergovernmental Panel on Climate Change was created by the United Nations Environment Programme and World Meteorological Organization in 1988. It is an organisation of governments that are members of the UN or WMO. Presently, there are 195 members. The main objective of the panel was to provide scientific and rational information to all the governments of the world so that they can develop climate policies.

The main activity of the panel is the preparation of reports which provides an important

input into global climate change negotiations. IPCC prepares three types of reports namely assessment reports, synthesis report and methodology report.

The Assessment Reports provides the state of the scientific, technical and socio-economic knowledge and basis of climate change, its effects, predictive risks and ways for adaptation and mitigation.

Thousands of people across the globe voluntarily contribute to work with IPCC in the form of report preparation and review reports. IPCC is divided into three working groups -

Group I - Physical science basis of climate change

Group II - Climate change impact adaptation and vulnerability

Group III - Mitigation of climate change

The first IPCC report played a pivotal role in the formation of UNFCCC, an international treaty to reduce global warming and combat the effects of climate change. Presently, the panel is working on the sixth Assessment Report that constitutes the above mentioned first three working groups contribution and a synthesis report.

b. Paris Climate Agreement

Global efforts have been initiated to reduce the emission of greenhouse gases into the atmosphere by signing the Paris Climate accord. The agreement was designed to replace the Kyoto Protocol. The United Nations Framework Convention on Climate Change(UNFCCC) adopted the Kyoto Protocol in 1997 but it came into effect in 2005. It was consented by 141 countries. The protocol restricted 35 industrialised nations to reduce their emission by the year 2012 to 5 percent less than the level prevalent in the year 1990.

The Paris agreement was adopted in 2015 but came into effect in 2016. It is a legally binding treaty in which industrialised economies work towards reducing GHGs emission and limit global warming to less than 2% compared to pre industrial level. In addition to that, the Paris Agreement insists that developed nations should provide financial and technological support to underdeveloped nations.

INTEXT QUESTIONS 9.5

1. Fill in the Blanks with suitable words:

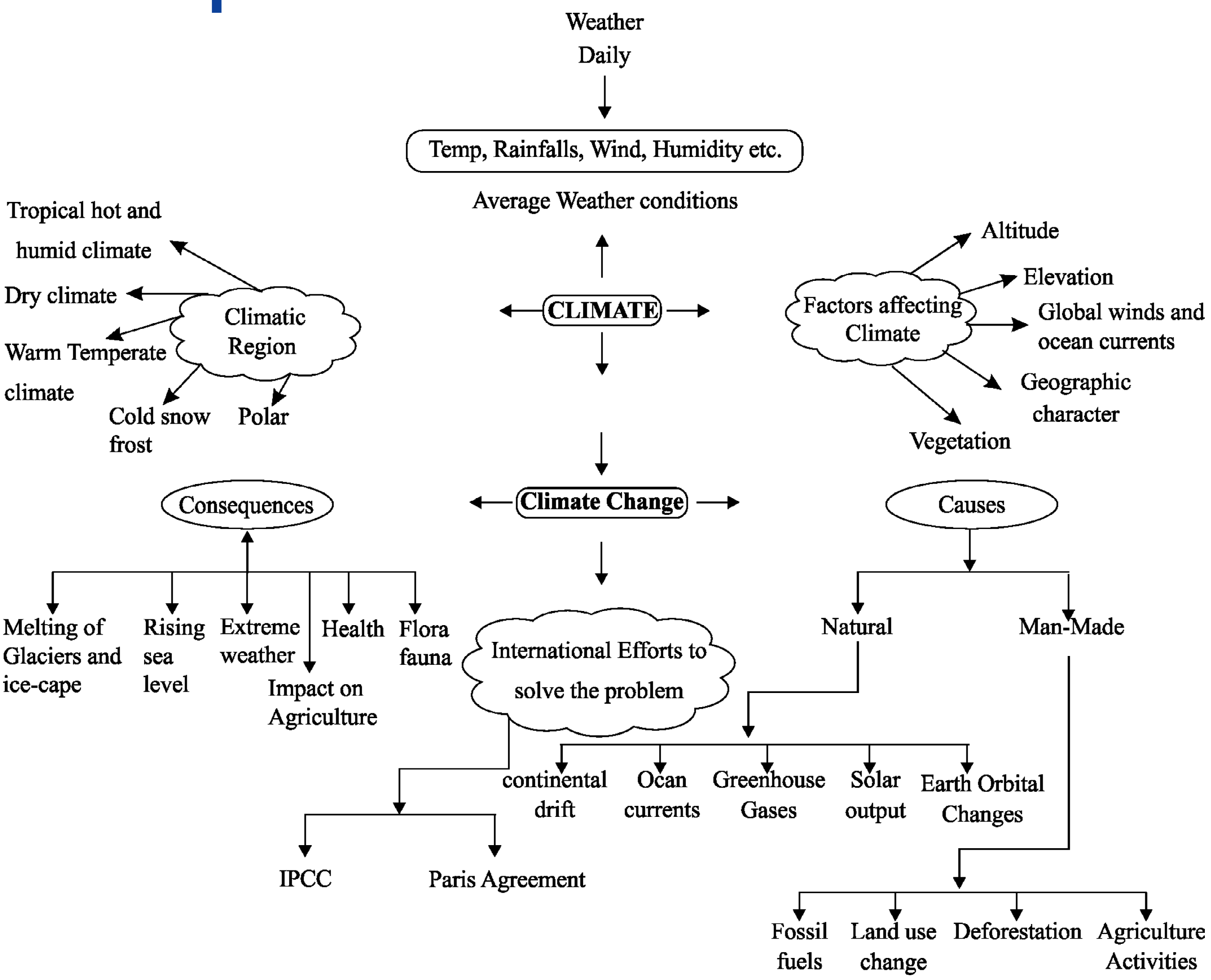
   (i) The main objective of......... to provide scientific and rational information to all the governments of the world so that they can develop climate policies.

(ii) The Intergovernmental Panel on Climate Change was created by the ……………………. and ………………………..

(iii) The Paris agreement designed to replace ……………..

(iv) The ……………agreement limits global warming to less than 2% compared to pre industrial level.

WHAT YOU HAVE LEARNT



TERMINAL QUESTIONS

1. Differentiate between weather and climate.
2. Discuss the climate regions of the world.
3. What are the factors that affect the climate of a region?

4. Define global warming. Why is the issue important?
5. What is Climate Change?
6. What is the significance of the Paris Agreement?
7. Define the term Greenhouse. Make a list of greenhouse gases.
8. Elaborate the factors that are propelling climate change?
9. Describe the major effects of climate change?
10. ExplAIn the important global initiatives taken to combat climate change?

ANSWERS TO INTEXT QUESTIONS

9.1

(i) F	(ii) F	(iii) T	(iv) F	(v) T

9.2

(i) c	(ii) b	(iii) c	(iv) c	(v) a

9.3

(i) Geological records, historical records

(ii) Global warming

(iii) global

(iv) greenhouse effect

9.4

(i) d	(ii) a	(iii) e	(iv) b	(v) c

9.5

(i) IPCC (ii) UNEP and WMO (iii) Kyoto Protocol

(iv) Paris agreement (v) 2016

PROJECT WORK/ACTIVITY

1. Try to find out how you can protect an endangered species in your area.
2. Prepare a report on the initiatives taken to combat climate change in your area.

MODULE -5

Biogeography and Biodiversity

10. Biosphere, Biomes and Biodiversity

10

BIOSPHERE, BIOMES AND BIODIVERSITY

You might be aware about different realms of the earth that are the lithosphere, the atmosphere and the hydrosphere. Life in all forms exists in all these three realms. Thus, the zone where life exists is known as the biosphere. You are also aware that our earth is the only planet in the solar system where life exists. This lesson will enable you to comprehend basic concepts of Biosphere and Biomes and their characteristics. There are several Biosphere reserves found in India. You will be able to locate them on the map of India. Moreover, this lesson will help you to sensitise others for protection of the environment and take necessary steps for its conservation.

OUTCOMES

After studying the lesson, learner:

- describes the term i.e Biosphere, Biodiversity and Biome;
- classifies different types of Biomes of the world;
- explains characteristics of different types of Biomes;
- locates biomes on the world map;
- illustrates various causes and consequences of loss of biodiversity and
- justifies the initiatives taken for conservation of biodiversity from local to global.

10.1 BIOSPHERE

You might have observed in your surroundings that different types of organisms or creatures are found on the land, water and air. Some animals or plants may be available everywhere while some may be found in any specific area.

All these enquire about an area where land, water and air are available is called a biosphere. It can be defined as "The narrow zone of contact between land, water and air, where life exists, is called Biosphere."

All the living creatures on the earth including plants, animals and humans are linked to each other as well as interact with other environmental realms i.e. lithosphere (land), hydrosphere (water) and atmosphere (air). Moreover, there are also many organisms that move from one realm to the other to survive.

Can you give any examples of organisms that live on land and water both? You might have read that the environment of the earth is made up of abiotic and biotic components.

a. Abiotic component

For the survival of living organisms various elements such as sunlight, water, minerals, and different gases are required. These elements do not have life but are essential for the living beings. They are called Abiotic components.

b. Biotic component

The biotic components may broadly be divided into the plants and the animals. All living beings whether plants or animals from micro to macro levels are called Biotic components.

ACTIVITY

Make a list of such organisms that live on land, water and air.

10.2 ECOSYSTEM

An ecosystem is a system in which plants and animals are linked to their environment through a series of links. For example, the ecosystem of small water bodies i.e. ponds or lakes. A lake or pond may be a water body of stagnant water. Generally such a lake receives water from rainfall or from any streams. The water from the lake evaporates due to solar energy. Due to direct sunlight the upper layers of the water body get warmer and there is a vertical difference in water temperatures. Thus the physical process is responsible for change in temperature in water, water flow, deposition of sediments in the bottom, etc. At the same time biological processes are also going on in the water body. The biological processes are more complex in which biotic organisms provide food to small larvae which are consumed by small fish. These small fish are eaten by larger fish, which provide food for other animals including humans. When the biotic organisms like plants and animals die and decay, they release chemicals back into the water body.

INTEXT QUESTIONS 10.1

Fill in the blanks:

1. The Banyan tree is ……..component of the environment.
2. Temperature of water changes due to ……. Process.
3. Biosphere includes ……. and …….. component.
4. All creatures of the environment including animals and plants are ……… with each other.

10.3 FOOD CHAIN IN THE ECOSYSTEM

You know that all living beings whether micro organisms like insects or macro level such as tigers, elephants or humans get their food from plants, either directly or indirectly. Now you are aware about the lake ecosystem where a simple food chain is stretching from the millions of microscopic plants on a lake surface to humans as fishermen. There are different levels in a food chain. It can be understood through a pyramid diagram. In the pyramid each level is termed as a Trophic level. Trophic word originates from the Greek word trophies, which means food. The base level (T1) of the pyramid is composed of natural vegetation. The second level (T2) consists of herbivorous animals that feed on the plants; the third level of pyramid (T3) is composed of carnivorous animals that depend on herbivorous animals; carnivorous animals such as humans that consume other carnivorous animals and all others which are found in lower levels are on the fourth level (T4) of the pyramid. Decomposers are found on the fifth level, which break down the dead tissues of organisms at all the other levels of the food chain.

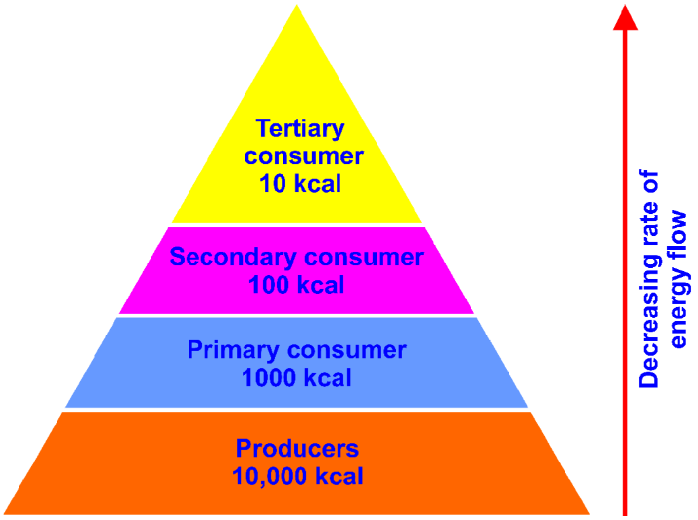


Fig. 10.1 Food Pyramid

Ecosystems can be of two types:

I. Terrestrial Ecosystem

II. Aquatic Ecosystem

I. Terrestrial Ecosystem

Terrestrial ecosystem covers about 29% of the land area on the earth surface. The major source of food and raw materials are found in this ecosystem because a variety of flora and fauna are available here for humans. The terrestrial ecosystems are further subdivided into various sub-types. Major sub types are (i) upland or mountain ecosystem (ii) low land ecosystem and (iii) desert ecosystem. You will be surprised to know that the maximum life forms are found in lowlands on the earth and this diversity decreases with increasing altitude since the level of oxygen and atmospheric pressure decreases with increase in height.

II. Aquatic Ecosystem

Aquatic ecosystem includes various forms of water available on the earth surface which covers about 71% of the entire earth. Aquatic ecosystems can further be divided as (i) fresh water, (ii) estuarine (iii) marine. In terms of size or extent it may range from open sea, lake, pond, etc. The biodiversity in aquatic ecosystems depends on the depth up to which sunlight can penetrate and the availability of nutrients and the concentration of dissolved oxygen. Keeping all these factors in view, estuarine ecosystems are found the most productive of aquatic eco-systems. On the ocean surface, shallow continental shelves are more productive than other configurations of ocean floor and open oceans. Open oceans are the least productive of all aquatic ecosystems. They are like the deserts in the terrestrial ecosystem. Some of the organisms exclusively live in water whereas some of the organisms can live in water and on land i.e. frogs, crocodiles, hippopotamus, etc. Moreover, some organisms live only in either fresh water or saline water and some others live in fresh and saline water both.

INTEXT QUESTIONS 10.2

Marks (✓) for True or (✕) for False:

1. Humans are found on the base level of the pyramid depicting the food chain.
2. Herbivore animals feed on plants.
3. Carnivorous animals feed on plants.
4. Decomposers break down dead tissues of organisms.

ACTIVITY

Explore which organisms are found only in fresh waters.

10.4 BIOMES

A biome is a plant and animal community which comes under a terrestrial ecosystem that covers a large geographical area. The boundaries of different biomes on land are determined mainly by climate and types of vegetation. Therefore a biome can be defined as the total assemblage of plant and animal species interacting within specific geographical conditions. These conditions include specifically rainfall, temperature, humidity and soil conditions. Some of the major biomes of the world are: forest, grassland, desert and tundra biomes

Biome can be subdivided on the following basis:

1. On the basis of climatic conditions, primarily temperature and humidity: there are four major types of biomes:

   (i) Forest biome

   (ii) Savanna biome

   (iii) Grassland biome

   (iv) Desert biome

Table 10.1 - Biomes of the World

Biomes	**Sub types**	**Regions**	**Flora and Fauna**
Forest	A. Tropical 1. Equatorial 2. Deciduous B. Temperate C. Boreal	A1-10°N-S A2-10°-25°N-S B- Eastern North America, N.E. Asia, Western and Central Europe C- Broad belt of Eurasia and North America, parts of Siberia, Alaska, Canada and Scandinavia	A1-Multi-layered canopy, tall and large trees A2-Less dense, trees of medium height; many varieties co-exist, insects, bats, birds and mammals B. Moderately dense broadleaf trees, less diversity of plant species, Oak, birch, maple etc. are common

Notes

			trees. Squirrels, rabbits, black bears, mountain lions, etc. are common animals. C. Evergreen conifers like pine, firand spruce etc. Woodpeckers, hawks, bears, wolves, deer, hares and bats are common animals.
Desert	A. Hot and Dry B. Semi -Arid C. Coastal D. Cold	A. Sahara, Kalahari, Thar, Rub-al-e-Khali B. Marginal areas of hot deserts C. Atacama D. Tundra climatic regions	A-C- Scanty vegetation; few large mammals, insects, reptiles and birds D-Rabbits, rats, antelopes, and ground squirrels
Grassland	A. Tropical Savannah B. Temperate Steppe	A. Large areas of Africa, Australia, South America , and India B. Parts of Eurasia and North America	A. Grasses: trees and large shrubs absent; giraffes, zebras, buffaloes, leopards, hyena, elephants, mice, moles, snakes, worms, etc. are common animals B. Grasses; occasional trees such as cottonwoods, oaks and willows, gazelles, zebras, rhinoceros, wild horses, lions, varieties of birds, worms, snakes etc. are common animals
Aquatic	A- Freshwater B- Marine	A- Lake, river, streams and wetlands B- Oceans, coral reefs, lagoons and estuaries	Algal and other aquatic and marine plant communities with varieties of water dwelling animals

Notes

Altitudinal	Slopes of high mountain ranges like the Himalayas, the Alps etc.	Deciduous to tundra vegetation varying according to altitude

2. On the basis of climate and vegetation-

For detaied study these biomes have been identified:

(i) The Evergreen Rainforest Biome

(ii) The Temperate Grassland Biome

(iii) The Arctic Tundra Biomes

i. The Evergreen Rainforest Biome

The evergreen rainforest biome is found in the equatorial zone extending 10° North and South latitudes from the equator. These evergreen forests are found in the equatorial belt including areas of Amazon lowland of South America, Congo basin of Africa and islands of South East Asia. As you are aware the sun rays fall directly on the equator throughout the year therefore the area experiences high temperature .This area also gets heavy rainfall throughout the year ranging between 150 cm - 250 cm. Every day in the afternoon heavy rainfall (convectional rainfall) occurs in this region. You might have read about convectional rainfall in the lessons on climate. In equatorial areas high temperature and rainfall are helpful for the growth of a variety of natural vegetation and wildlife.

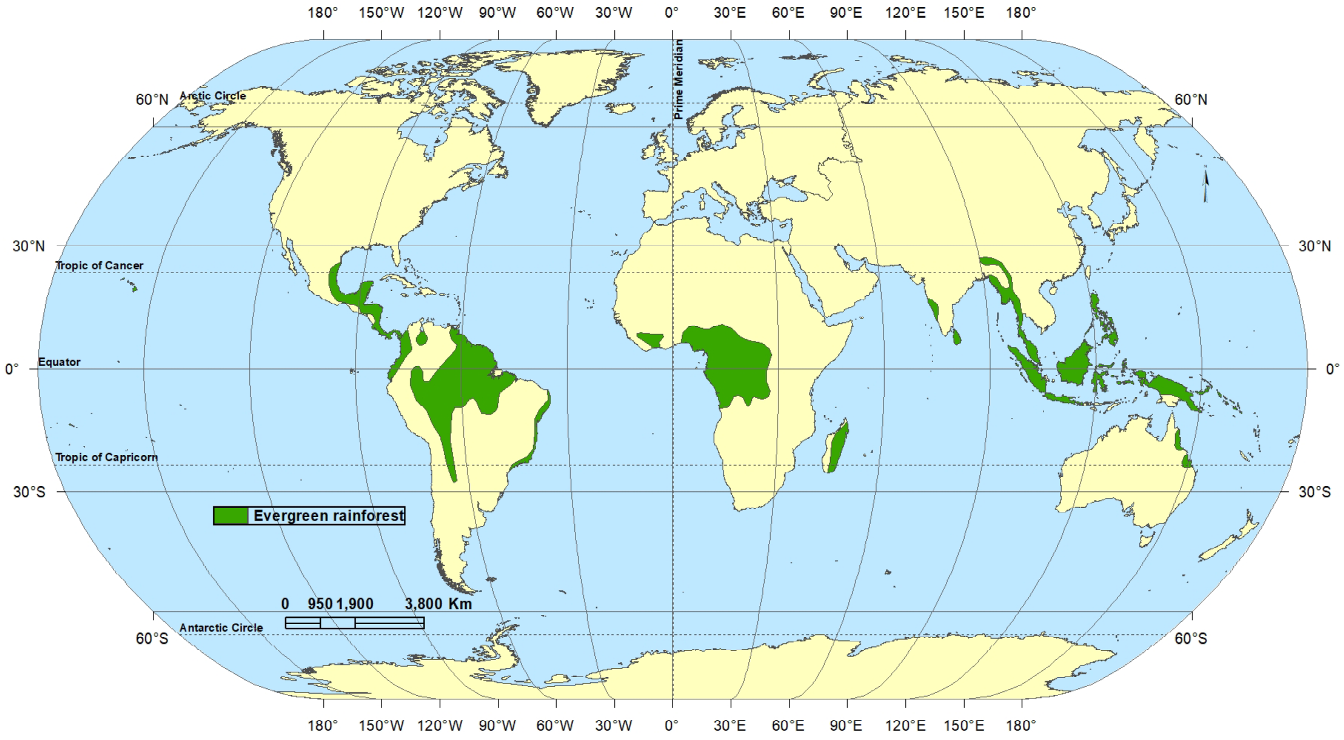


Fig. 10.2 The Evergreen Rain forest Biome

Trees of evergreen forests have generally buttressed trunks and shallow roots. There are three levels of evergreen rainforests,

i. The canopy or upper level where height of trees are about 20 metres to 60 metres. These are hardwood trees for example ebony, rose wood, sandalwood, cinchona, mahogany, etc.

ii. The intermediary level or second level where the height of trees is about 10 metres to 20 metres. Palm is an important species of this level. Besides that other parasitic plants are also found in this layer

iii. The lower level or third level where height of vegetation is about 10 metres from the surface. In this level a variety of plants such as ferns, mosses, orchids, etc. are found. Because of tall and broad leaf dense plants here sunlight does not reach the ground. Therefore the surface layer is always wet and muddy. Evergreen rainforest is inhabited by numerous wildlife species like elephants, lemur, birds, reptiles, insects, etc. The water bodies of the equatorial areas are also rich in animal life with alligators, fishes, frogs, Hippopotamus etc. Because of the impenetrability and high vegetation growth in the lower part, most of the insects, birds and animals reside on the branches of the trees. Generally, they do not come down to the ground. The productivity of the tropical rainforest biome is the highest of all biome types of the world. It may be pointed out that the rainforest biome represents only 13 percent of the total geographical area of the world but this biome accounts for 40 percent of the total productivity of the world.

For the last several decades people from other areas have encroached this area and started exploiting natural resources in the name of various developmental activities. These rainforests contain about 40% of all known species of plants and animals of the world. Deforestation of rainforest is just not ecological but also has very adverse environmental consequences. These evergreen forests are known for carbon sinks which help to reduce the impact of global warming on the earth.

ii. Temperate Grassland Biome

Temperate grasslands located in temperate zones, by the northern hemisphere i.e. Eurasia and North America have continental types of climate. Whereas grasslands in the southern hemisphere are located along the coastal areas of Australia and South America. Since these areas are located in the rain shadow areas of the high mountains, therefore receive scanty rainfall. These grasslands are called by different names in all these areas. For example in Eurasia, the grasslands are called the Steppes which extend towards east from the coasts of the Black sea to the plains of Manchuria in China. In North America, the grasslands lie between Rockies mountains and Great Lakes are called Prairies. In

South America these grasslands are known as Pampas in Argentina and Uruguay. In Africa these grasslands are found in South Africa and called Veldt. The same temperate grasslands of Australia are called Downs and are located in the Murrary - Darling river basins.

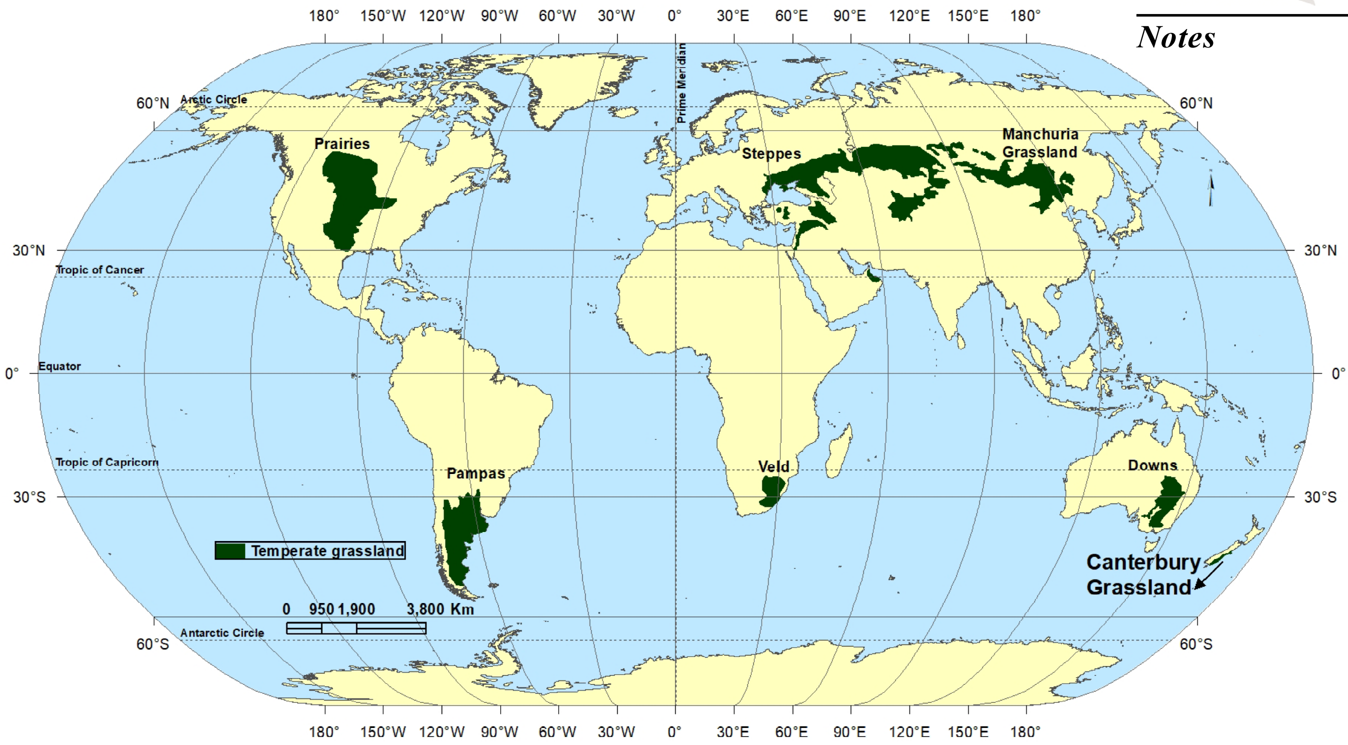


Fig. 10.3 Temperate Grassland Biome

ACTIVITY

Locate areas lying in the Temperate Zone on the outline map of the world.

As you are aware that regions that lie in temperate climates receive very less precipitation. The amount of precipitation is not sufficient for the growth of trees but is suitable for grass, therefore in this region extensive grasslands are found. In Eurasia Steppes grasslands are known for short and nutritious grass. These grasslands are known for different types of animals like antelopes, horses, wolves, kangaroos, emu, wild asses, wild dogs, etc.

These Areas are extensively affected by human interventions. Due to human intervention these temperate grasslands have been converted into agricultural fields and are known as 'granaries of the world'. Temperate grasslands are suitable for production of wheat. Another major activity in these grasslands is pastoralism or domestication of animals.

Notes

iii. Tundra Biome

Tundra biome is located in the northern parts of North America including Alaska, northern most areas of Canada, Greenland and the Arctic regions of Russia. This is a cold desert area where summers are very short and cool.

Natural vegetation includes grasses, mosses, lichens, etc. The animal species include resident and migrant animals. Resident animals are those which can adjust to the changing climatic conditions. Whereas migratory animals are those which start migrating to the warmer places in the very beginning of winter for example several birds such as water fowl, ducks, swans, geese etc. Some other animals of this region are reindeer, wolves, foxes, musk-ox, aortic hare, seal, etc. Productivity in tundra biomes is very low since this region receives very less amount of solar energy and most of the surface in the region is frozen throughout the year. Soils are also not developed and suitable for plants. In such circumstances the crop growing season is also very short.

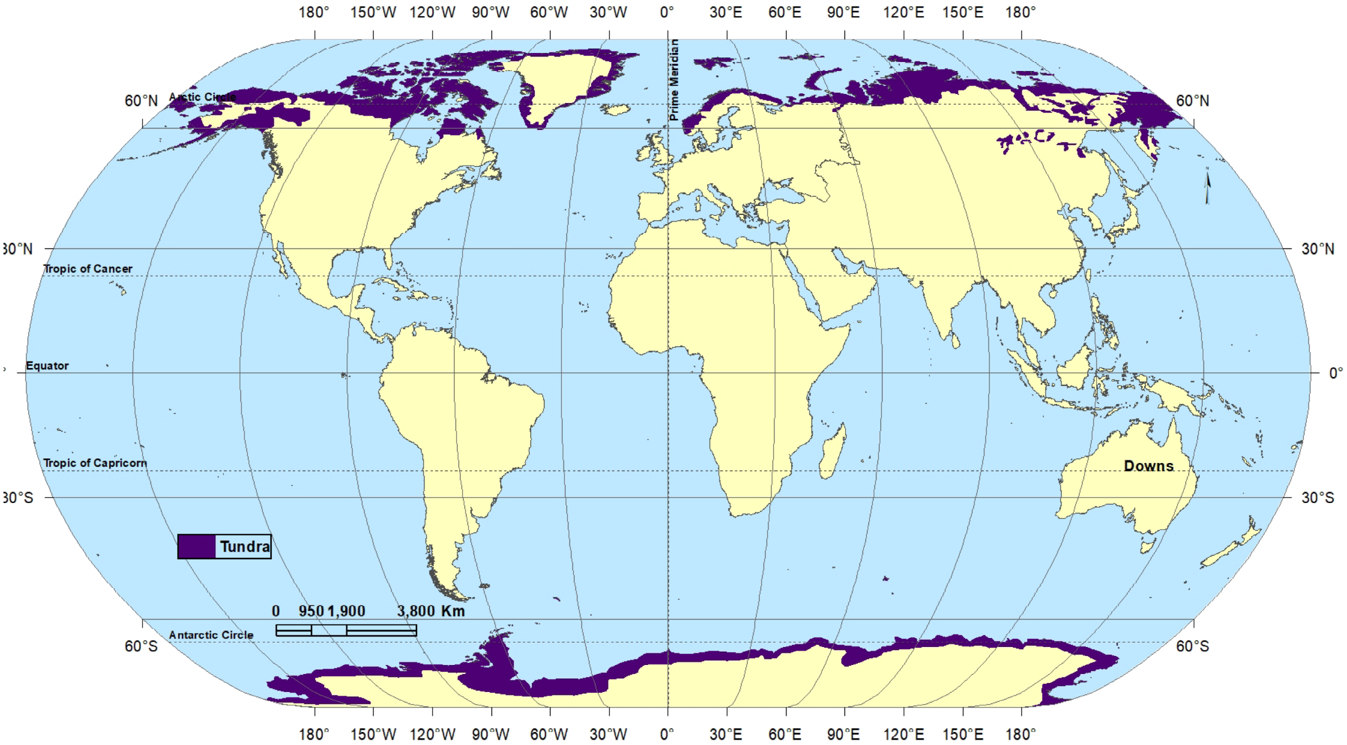


Fig. 10.4 Tundra Biome

Due to very harsh climatic conditions, the population here is very low. Some tribes such as Samoyeds, Lapps, Finns and Yakuts, Eskimos live in tundra regions of Eurasia, Canada and Alaska respectively. By introducing developmental work and modern technologies a lot of efforts are being done to bring these tribes into the mainstream.

INTEXT QUESTIONS 10.3

1. Explain the meaning of Biomes.
2. Name any two region where desert types of biomes are found.

ACTIVITY

Collect visuals of animals found in different Biomes and prepare a chart.

10.4 BIODIVERSITY AND ITS IMPORTANCE

The term Biodiversity originated from two words, Bio (life) and diversity (variety). Biodiversity may be defined as a specified geographical area where a variety of organisms including flora and fauna are found. It encompasses terrestrial and aquatic ecosystems formed by the varieties of plants, animals, and micro-organisms, including the genes these organisms contain. Biodiversity is related to the variability within the species and between the species and that within and between the ecosystems. As you are aware that biodiversity on the earth is very precious for all including living or non-living things. Actually biodiversity is a result of millions of years of evolutionary history of different species on the earth.

The impact of biodiversity on humans and humans on biodiversity is visible at all places of the earth. Biodiversity has contributed in various ways to the development of human cultures in all geographical regions of the world as well as Human societies in all parts of the globe have also played an important role in shaping the diversity of nature at different levels.

DO YOU KNOW?

Every year on 22 May is celebrated as International Biodiversity Day.

In an ecosystem each and every organism extracts its needs from others and also contributes something useful to other organisms. If an ecosystem is more diverse then there are more chances for species to survive through adversities and attacks and as a result the whole ecosystem becomes more productive. Therefore the loss of species in any ecosystem will decrease the capability of the ecosystem to maintain itself. Hence, the variety of species in an ecosystem makes it more stable.

Biodiversity is an important resource for all human beings in their daily life. In terrestrial ecosystems an important part of agro-biodiversity is 'crop diversity'. Apart from that other economic commodities such as food crops, livestock, forestry, fish, medical resources, etc. are also provided by the natural biodiversity to humans.

ACTIVITY

Enlist the commodities provided by nature to humans.

Biodiversity enables us to understand how life functions and the role of each and every species in sustaining the ecosystems of which humans are also a species. That is why biodiversity is necessary to sustain life on the earth and it is the responsibility of humans to consider that each and every species along with us have a basic right to exist on the earth. If the level of biodiversity is high that means the state of our relationships with other living species in the ecosystem is good.

Loss of Biodiversity

Fast growth of population and subsequently increasing demands of resources have accelerated the rate of consumption of natural resources tremendously in the world over. It has also increased the loss of different species and their habitations in all parts of the world. The impact of the growing population may be seen in tropical regions which occupy only about one -fourth of the total area of the world and contain about three fourth of the world population. In these areas over exploitation of the natural resources and deforestation to fulfil the needs of a large population have become a great cause of concern. The tropical rain forests contain about fifty per cent of the different species on the earth therefore destruction of natural habitats of wild flora and fauna in these forests have proved disastrous for the biosphere of the entire world.

Natural calamities such as earthquakes, floods, volcanic eruptions, forest fires, droughts, etc. cause damage to the flora and fauna of the earth. Pesticides such as hydrocarbons and toxic heavy metals and other pollutants destroy the weak and sensitive species. Species which are not the natural habitants of the local habitat but are introduced in the systems, are called "exotic species". There are many examples when a natural biotic community of the eco systems suffered extensive damage because of the introduction of exotic species.

DO YOU KNOW?

Chir is an exotic species which was planted in the Himalayan areas during colonial time in India.

Conservation of Biodiversity

Biodiversity is important for human existence. All forms of life are so closely interlinked that disturbance in one gives rise to imbalance to the others. If species of plants and animals become endangered they cause degradation in the environment, which may threaten human beings' own existence.

There is an urgent need to educate people to adopt environment-friendly practices and reorient their activities in such a way that our development is harmonious with other life forms and is sustainable. There is an increasing consciousness of the fact that such conservation with sustainable use is possible only with the involvement and cooperation of local communities and individuals.

DO YOU KNOW?

Every year World Sparrow Day is celebrated on 20th March. This is the most common bird species in urban areas in India. Sparrows are generally found in groups and feed on grains. Now numbers of these house sparrows are declining due to various reasons.

Can you find out the reasons?

ACTIVITY

The Bishnois community living in north India is known for conservation of natural vegetation and wildlife in India. There are several other communities in India who depend on forests for their livelihood. Collect information about them.

There is a need to develop local level institutions like Van Panchayat for forest management and to promote practices for conservation of species and their habitats. Such institutions are very active in some states like Uttarakh and. Moreover, school students can also take initiatives by organising local level events for sensitising and motivating local communities in the process of forest and wildlife conservation and management.

The government of India along with other nations have signed the Convention of Biodiversity at the Earth Summit held at Rio -de-Janeiro, Brazil in June 1992.The Convention of biological diversity covers biodiversity at all levels including ecosystems, species and genetic resources.

In India several national parks and sanctuaries have been established to protect, preserve and propagate the variety of wildlife species within natural boundaries.

ACTIVITY

Prepare a list of national parks and show them on the map of India.

Countries which are situated in the tropical region possess a large number of the world's species diversity. There are some countries namely, Mexico, Columbia, Ecuador, Peru, Brazil, Zaire, Madagascar, China, India, Malaysia, Indonesia and Australia in which mega biodiversity places are located. In order to concentrate resources on those areas that are most vulnerable, the International Union for Conservation of Nature and Natural Resources(IUCN) has identified certain areas as biodiversity hotspots As you are aware that different types of vegetation are very significant since these determine the primary productivity of any ecosystem. Hence, hotspots are defined according to different vegetation species found in the area.

ACTIVITY

Locate countries situated in tropical regions known for rich biodiversity. Identify Biodiversity Hotspot on the map of India.

INTEXT QUESTIONS 10.4

1. Name any 3 countries which has mega Biodiversity hotspots.
2. In which year India has signed the convention of biodiversity.

WHAT YOU HAVE LEARNT

- Biosphese
  - Biotic Component
  - Abiotic Component
  - Ecosystem
    - Terrestrial
    - Aquatic
    - Food chain
  - Biomes
    - On the basis of climatic condition
    - On the basis of climate & vegetation
  - Biodiversity & its importance
    - Loss of Biodiversity
    - Conservation of Biodiversity

TERMINAL QUESTIONS

1. What is a biome? Explain types of biomes.
2. Explain the characteristics of the evergreen rainforest biome.
3. Distinguish between Tundra and Temperate biomes.
4. What is the importance of Biodiversity?
5. What efforts should be done to conserve Biodiversity?

ANSWERS TO INTEXT QUESTIONS

10.1

1. Biotic
2. Physical
3. Biotic, Abiotic
4. linked

10.2

1. False
2. True
3. False
4. True

10.3

1. A biome is plant and animal community which comes under a terrestrial ecosystem that covers a large geographical area.
2. Sahara, Valahar, Thar, etc. (any 2)

10.4

1. Mexico, Peru, India, China, Indonasia etc (any 2)
2. 1992

MODULE -6

Physical Geography of India

11. Physical Settings

12. Climate

13. Natural Hazards and Disasters

11

PHYSICAL SETTINGS

India or Bharat, our nation, is an ancient country. It is surrounded on three sides by the sea, with a high mountain range separating it from the rest of Asia. As a result, the Indian subcontinent has emerged as a separate entity. India is the world's seventh-largest country by area. It is a vast country with a wide range of physical characteristics. As a result, it is essential to have some understanding of its basic physical settings. You may become familiar with its significant features such as the location of India in terms of neighbouring countries, major physiographic divisions and their salient features, the drainage system, and unity in diversity in India.

OUTCOMES

After studying this lesson, learner:

- locates India in terms of neighbouring countries;
- describes major physiographic divisions of India and their salient features;
- describes the drainage system and
- explains unity in diversity in India.

11.1 LOCATION OF INDIA AND ITS NEIGHBOURING COUNTRIES

A vast landmass of South Asia is flanked by new fold towering mountains on the northwest, north, and northeast. The Arabian Sea lies to its south west, the Bay of Bengal to its south east, and the Indian Ocean to its south. This well-defined South Asian landmass is called the Indian subcontinent. This sub-continent consists of the countries of India, Pakistan, Bangladesh, Nepal, and Bhutan, including Sri Lanka, an island narrowly separated by the Palk Strait. India alone covers about three-fourths of the area of this sub-continent and has a common frontier with each one of them. Our country and five neighbours form an identifiable geographical

unit with certain common cultural parameters. Since old times, the country has been known by various names such as Jambudvipa, Aryavarta, Hindustan, and Bharat, and presently it is called India. The Indian Ocean, or Hind Mahasagar, has also been named after India - the only country is to be named. According to the Constitution of India, the country is known as Bharat or India.

India lies wholly in the northeastern hemisphere. The Indian mainland extends between 8°4'N to 37°6' N latitudes and from 68°7' E to 97°25' E longitudes. Thus, the latitudinal and longitudinal extent of India is about 29 degrees. It measures about 3,214 km from north to south and 2,933 km from east to west. The southern most point of mainland India is Kanyakumari in Tamilnadu. However, the country's southernmost point lies further south in Andaman and Nicobar Islands. It is now called Indira Point. It is situated at 6°45'N latitude. The western most point of India is Ghuar Moti, which lies in the Kutch district, Gujarat, and the easternmost point is Kibithu, which lies in Arunachal Pradesh.

Let us see the impact of such a large latitudinal extent on the lives of the people of India. The northern parts of the country are quite far off from the equator. Therefore, the rays of the sun strike those parts more obliquely. Consequently, this part of the country receives less insolation and has a cold climate, unlike the southern regions. Secondly, the difference between the length of day and night in the southernmost part of India is much less, only about 45 minutes, as they are situated near the equator. This difference between day and night in the northern parts of India steadily goes on increasing till it becomes as much as 5 hours.

The Tropic of Cancer passes almost halfway through the country from eight states i.e. Gujarat, Rajasthan, Madhya Pradesh, Chattisgarh, Jharkhand, West Bengal, Tripura, and Mizoram. Thus half of the country to the south of the Tropic of Cancer is situated in the Tropical or Torrid zone, and the other half lying north of the Tropic of Cancer falls in the Sub-tropical zone.

The earth takes 24 hours to complete one rotation on its axis. The Sun rises first in the east and then in the west because the earth rotates from west to east. The earth's longitudinal expanse of 360° is thus covered in 24 hours at the pace of 15° per hour. As the longitudinal extent of India is nearly 29°, the real-time difference in India between its eastern and western extremities is roughly two hours. While at the eastern extremity of India, the day may have just broken out, the extremity of the west would take nearly another two full hours to do so.

To iron out this big chunk of the time difference, India, like all other countries of the world, follows the local time of its relatively central meridian as the standard time for the whole country. Each country chooses its standard meridian in a multiple of 7°30' for convenience. Accordingly, the standard meridian of India has been selected to be 82°30' E.

Notes

Fig. 11.1: India: Longitude and Latitude Extents

The north-central part of India is broad, while the southern part tapers down towards the Indian Ocean in the south. Thus, the northern part of the Indian Ocean has been divided into two by the sheer presence of the Indian Peninsula. The western part of the north Indian Ocean is called the Arabian Sea, while the eastern part is called the Bay of Bengal. The total length of the coastline of India, including the island groups, is about 7,516.6 km. The Palk Strait separates the Indian mainland from Sri Lanka.

India accounts for 2.42 percent of the world's total land area, whereas it sustains about 17 percent of the world's population. The land frontiers of India measure 15,200 km. Pakistan, Afghanistan, China, Nepal, Bhutan, Myanmar, and Bangladesh share common boundaries with India. The kingdom of Bhutan is situated in the Eastern Himalayas. Most of our boundary with Pakistan and Bangladesh is almost manufactured. There is no mountain range or river to form a natural boundary. The international border of India passes through various landforms - barren desert lands, lush green agricultural fields, gushing rivers, snow-clad mountains, and densely forested mountain ranges.

INTEXT QUESTIONS 11.1

1. Fill in the blanks:

   i. The Indian mainland extends between .... to ....north latitude.

   ii. The southern most point of India is called ....

   iii. 82°30' E longitude is called .... meridian of India.

   iv. The land frontiers of India measure ....kms.

2. Answer the following questions in one word or a sentence.

   i. By which parallel of latitude is India divided into tropical and temperate belts?

   ii. How much is the real time difference between its eastern and western extremities?

   iii. Name the southernmost point of India republic.

11.2 PHYSIOGRAPHIC DIVISIONS OF INDIA AND THEIR SALIENT FEATURES

India is a land of physical diversities. Almost all types of dramatic and breathtaking landforms are found here. According to one estimate, 29.3 percent of the area of India is occupied by mountains and hills, 27.7 percent by plateaus, and 43 per cent by plains.

From a physiographic point of view, India can be divided into the following six regions:

A. The Northern Mountains

B. The Northern Plains

C. The Peninsular Plateau

D. The Indian Desert

E. The Coastal Plains

F. The Islands

Let us know more about these physiographic divisions.

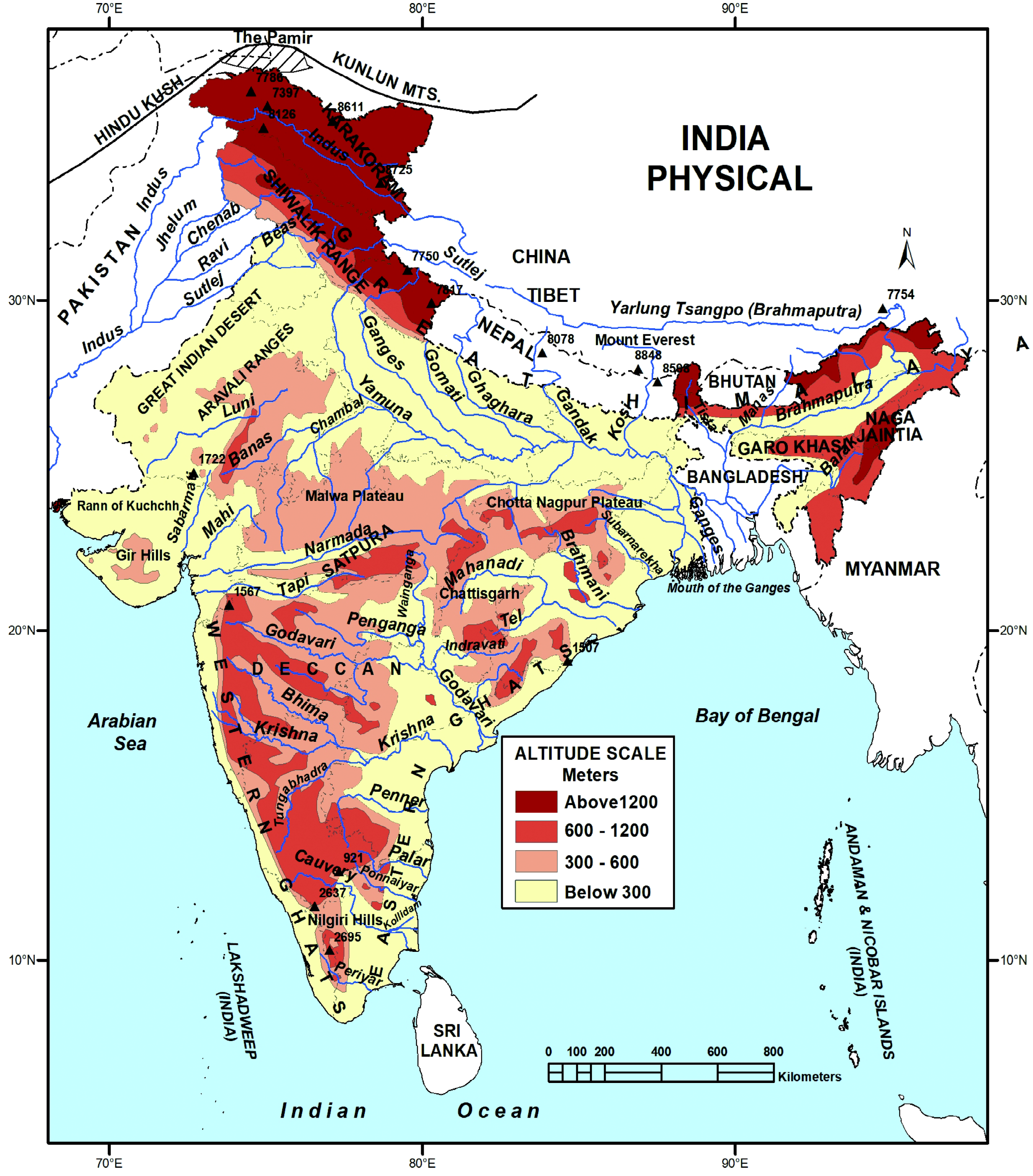


Fig. 11.2: Physiographic Divisions of India

A. The Northern Mountains

They include the mountains and plateaus of northern Kashmir, the Himalayas and the hills of Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, and Meghalaya. They are divided into three groups. They are:

a. The Himalayas

b. The Trans-Himalayas

c. Purvanchal or the hills of the north-east

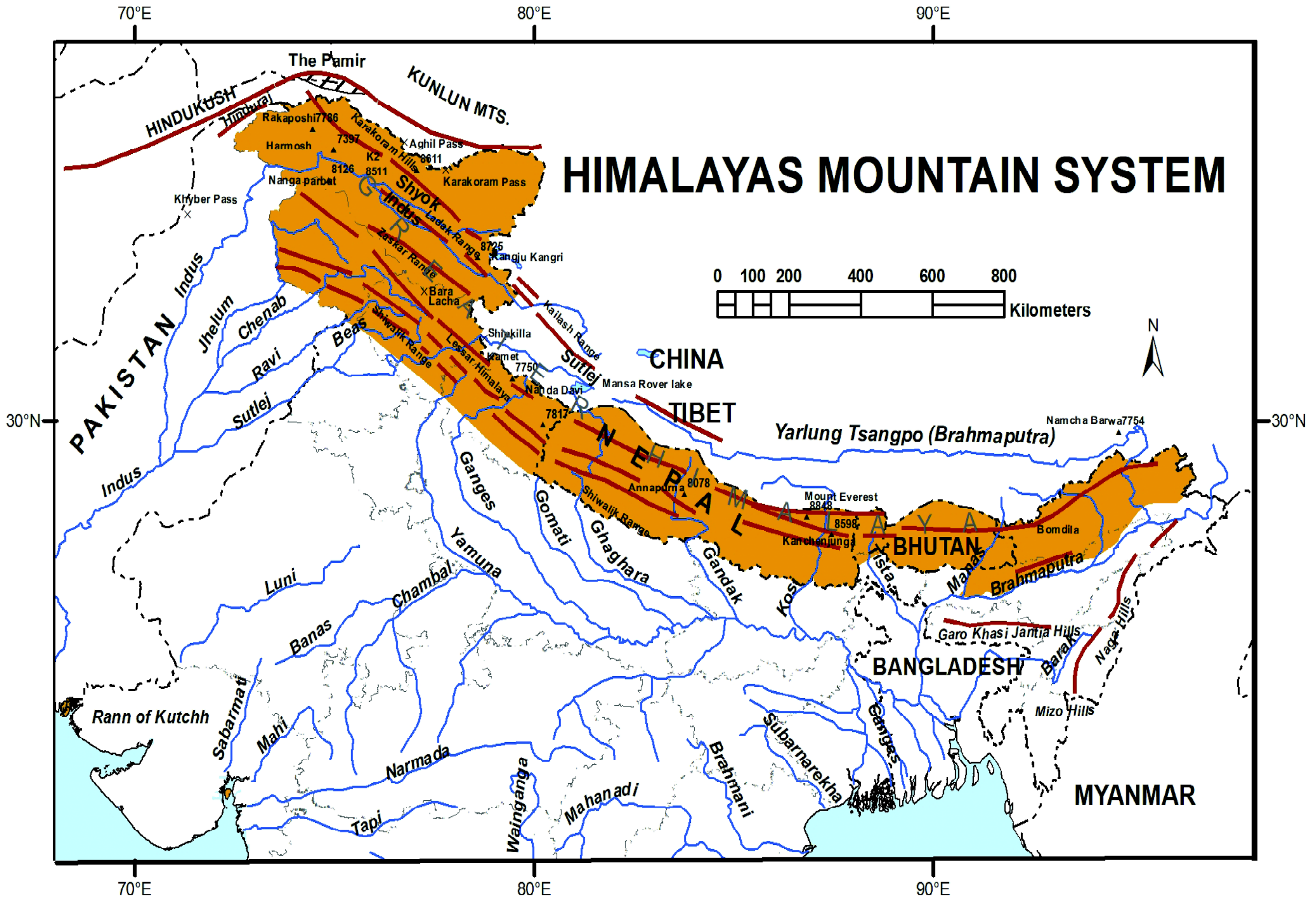


Fig. 11.3 Himalayas Mountain System

a. The Himalayas

It is the highest mountain range in the world. It extends in the shape of an arc for a distance of about 2500 km from west to east along the northern boundary of India. It is spread between the Indus gorge in Ladakh in the west and Brahmaputra gorge in Arunachal Pradesh in the east. The breadth of the Himalayas ranges between 400 km

in the west to 150 km in the east. The area covered by this mountain system is about 5 lakh square km. It has three major ranges. Deep valleys and plateaus separate these ranges. The southern slopes of the Himalayas facing India are steeper, and those facing the Tibetan side are generally gentler. In the east, the Himalayas rise almost abruptly from the plains of West Bengal and Assam. That is why two of the highest peaks of the Himalayas, Mt. Everest (in Nepal) and Kanchenjunga are not very far from the plains.

On the other hand, the western part of the Himalayas rises rather gradually from the plains. Hence, the higher peaks in this part are farther from the plains, and several ranges lie between the plains and the high mountain. The high peaks of this part, such as Nanga Parbat, Nanda Devi, and Badrinath, are very far from the plains.

Three parallel ranges can be identified in the Himalayas. These are:

i. Himadri

ii. Himachal and

iii. Siwalik

i. **Himadri (Greater Himalaya):** Himadri is the northern most and highest range of the Himalayas. It is the only Himalaya range that maintains its continuity from west to east. This range's core comprises granite rocks flanked by metamorphic and sedimentary rocks. The extent of this range is between the Nanga Parbat peak (8126 m.) in the west and the Namcha Barwa peak (7756 m.) in the east. The average height of this range from sea level is about 6100 metres. Over 100 peaks have a height of more than the average height of the range. The highest peak in the world, Mount Everest (8848 m), is situated in this range. Kanchenjunga, Makalu, Dhaulagiri, and Annapurna are some other peaks with a height of more than 8000 metres. Kanchenjunga is the highest peak of the Himalayas in India. The Himadri range is snow-clad throughout the year. There are many large and small glaciers. After the melting of snow and ice, their water falls in the rivers of northern India and make them perennial. Gangotri and Yamunotri are good examples of such glaciers. The Himadri range can be crossed through some passes like Zojila, Shipki La, Niti, Nathula, etc.

ii. **Himachal (Lesser or Middle Himalaya):** It is located southwards of Himadri. The breadth of the Himachal range is 60 to 80 km, and the height varies from 1000 metres to 4500 metres. Some of the peaks of this range have a height of more than 5000 metres. This range is highly dissected and uneven. Rocks in this zone have been metamorphosed due to violent thrusts and compression. Therefore, this range mainly consists of metamorphosed rocks. The gentle slopes of the eastern part of this range are covered with dense forests. The south-facing slopes of other parts of this range are steep and generally devoid of vegetation. The north-facing gentle slopes of this range

Notes

are covered by dense vegetation. Pir Panjal in Jammu and Kashmir and Dhauladhar in Himachal Pradesh are the local names of this range. The beautiful valley of Kashmir extends between the Pir Panjal and Himadri ranges. The famous valleys of Kullu and Kangra are also a part of the Himachal ranges. Most hill towns or resort towns are located in the Himachal range. Shimla, Nainital, Mussouri, Almora, and Darjeeling are some famous hill towns. There are many beautiful lakes around Nainital.

iii. **Siwalik (Outer Himalaya):** The southern most range of the Himalayas is known as Siwalik. The Himadri and Himachal ranges were formed much before the Siwalik range. The rivers rising in the Himadri and Himachal ranges brought gravel, sand, and mud, deposited in the rapidly shrinking Tethys Sea. With time, the earth's movements caused the folding of these relatively fresh deposits of sediments, giving rise to the least close Siwalik range. The average height of the Siwalik range is very low, about 600 metres only. There are some broad valleys between the Himachal and the Siwalik ranges. These valleys are known as 'duns.' Dehradun valley is one of the best examples.

b. The Trans-Himalayan Ranges

There are some mountain ranges north of Himadri in Jammu and Kashmir. The range extending to the north of the Himadri and running parallel to it is called the Zaskar range. North of the Zanskar range is the Ladakh range. The river Indus flows north west between Zaskar and Ladakh ranges. Many scholars treat Zaskar and Ladakh ranges as parts of the Great Himalayas and include them in Kashmir Himalayas. North of the Ladakh range lies the Karakoram. The name of the Karakoram in Sanskrit literature is Krishnagiri; K2 (8611m) is the highest peak of the Karakoram Mountains. It is the second-highest peak in the world, next only to Mt. Everest.

Ladakh plateau is situated in the UT of Ladakh. This plateau is very high and arid. It forms one of the remote areas of our country.

c. Purvanchal

Purvanchal is the name given to all the hills of north east India beyond Brahmaputra gorge. The average height of these hills from sea level is 500 to 3000 metres. These hills are located in Southern Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, and Meghalaya. Mishmi, Patkai Bum, Naga, Manipur, Mizo (Lushai), and Tirupur are the major hilly ranges of this region. Meghalaya Plateau is also part of these hills of the north eastern region. This plateau includes the hills of Garo, Khasi, and Jaintia. However structurally, it is a part of Peninsular India.

Notes

INTEXT QUESTIONS 11.2

1. Name the three parallel ranges of Himalayas.

2. Name the highest mountain peak of the world.

3. Fill in the blanks:

   i. The beautiful valley of Kashmir extends between …….. and ……..

   ii. Famous hill stations such as Shimla, Nainital, Mussouri etc. are located in ……. Range.

   iii. The river Indus flows between ……….. and …….. range.

B. The Northern Plains

This plain extends from west to east, between the Himalayas in the north and Great Indian Plateau in the south. The plain extends from the arid and semi-arid areas of Rajasthan in the west to the Brahmaputra valley in the east. The area of this plain is more than 7 lakh square km. This plain is very fertile, and a very sizable part of the Indian population lives in numerous villages and big cities.

The northern plain comprises the soils brought down and deposited by the rivers flowing from the Himalayas in the North and the Great Indian plateau in the South. The rivers have deposited sediments in this plain for millions of years. Therefore, the alluvium in this plain is quite a few hundred metres deep. In some parts, the sediments' depth is as much as 2000 to 3000 metres.

This plain is almost dead flat. Its average height is 200 metres above the mean sea level; due to a very gentle slope towards the sea, the rivers in this plain flow leisurely and, sometimes, sluggishly. The slope from Varanasi upto the mouth of Ganga is only 10 cm. per km. The land around Ambala is a bit more elevated. However, it acts as a water divide between the two major river basins - the Satluj in the west and the Ganga in the east. Rivers lying eastwards of this water divide flow into the Bay of Bengal, while that west of it flows into the Arabian Sea.

The relatively higher part of the plain is called Bangar. This area is never covered with flood water from the rivers. Contrary to this, the comparatively lower area is called the khaddar. This area is flooded by streams almost every year. Khadar area is known as bet in Punjab.

There is a strip of plain about 10-15 km broad along the outer slopes of the Siwaliks in Punjab, Haryana, and Uttar Pradesh. This region is known as 'bhabar.' This strip of bhabar is made of gravel and coarse sand. The smaller streams disappear underground in the 'bhabar' region during summer, and their water surfaces again after crossing the bhabar. This water accumulates in the strip of plain about 15 to 30 km wide and extends to the south of bhabar. Accumulation of this water makes the land marshy. This marshy land is called the terai. Many parts of the terai have been reclaimed for agricultural purposes.

The great Northern Plain can be divided into four parts:

(i) Western plain,

(ii) North Central plain,

(iii) Eastern plain, and

(iv) Brahmaputra plain.

i. **Western Plain:** This region includes the Rajasthan desert and Bangar region lying to the west of the Aravalli ranges. The desert is partly rocky and partly sandy. Some geographers believed that in the ancient period, the perennial streams - Saraswati and Drishadvati - flowed through this region. This region includes the fertile area of Bikaner. River Luni flows through this Bangar region and falls into the Rann of Kutch. The famous saltwater lake of Sambhar is situated in this part of the plain.

ii. **North Central Plain:** This plain extends over Punjab, Haryana, and Uttar Pradesh. The part of this plain extending into Punjab and Haryana has been formed by the alluvium brought by rivers Satluj, Beas, and Ravi. It is a very fertile area. The part of this plain lying in Uttar Pradesh is made up of the deposits laid down by the rivers like Ganga, Yamuna, Ramganga, Gomati, Ghagra, and Gandak. This plain part is highly fertile and has been the cradle of Indian civilization and culture.

iii. **Eastern Plain:** This part of the great plains covers the middle and the lower Ganga valley lying in the states of Bihar and West Bengal. Ganga flows through the middle of this plain in Bihar. Ghagra, Kosi, and Gandak join Ganga from the north, while Son joins from the south. On entering West Bengal, the plain widens further, extending from the foothills of the Himalayas upto the Bay of Bengal. The southern part of the plain is the delta region. Ganga is divided into several distributaries in the delta region. Hooghly is the best example of a distributary of Ganga. This part of the plain is indeed very fertile and rainier.

iv. **Brahmaputra Plain:** The northeastern part of the Great Indian Plain extends into Assam. This plain was formed by the alluvium deposition brought down by river Brahmaputra and its tributaries. Brahmaputra is highly prone to devastating floods at regular intervals. After the floods, the river generally changes its course. This process has led to the formation of various islands in the river. Majuli (1250 square kilometres) in the Brahmaputra river is the world's largest river island. This part is also very fertile. It is surrounded by hills from three sides. Bangladesh is situated on this plain, and the delta is jointly formed by Ganga and Brahmaputra and their distributaries.

INTEXT QUESTIONS 11.3

1. Distinguish between Khadar and Bangar.

2. Name the four parts of the great Indian plain.

3. Fill in the blanks:

   i. Marshy land is called ....

   ii. Saltwater lake .... is situated in the western plain.

   iii. Hoogly is the best example of distributaries of ....

   iv. World's longest river islands .... situated in Brahmaputra river.

C. The Peninsular Plateau

The Peninsular plateau is a triangular-shaped landmass. It is part of an ancient land mass called the Gondwana land. It covers an area of nearly 5 lakh sq.km. It is spread over the states of Gujarat, Maharashtra, Bihar, Karnataka, Telangana and Andhra Pradesh. River Narmada divides the peninsular plateau into two parts: The central highlands and Deccan Plateau

a. **The Central Highlands:** It extends between the Narmada river and the northern plains. Aravallis is a mountain that rises from Gujrat through Rajasthan to Delhi. The highest peak of the Aravalli hills is Gurushikhar (1722m) near Mt. Abu. The Malwa Plateau and Chhota Nagpur plateau are parts of the central highlands. The paer of the central highlands which extends to the east of Malwa plateau is known as Bundelkhand and is further followed by Baghelkhand and ultimately to Chhota Nagpur plateau. Vindhyachal ranges form the southern range of Malwa plates. River Betwa, Chambal, and Ken are the important rivers of the Malwa plateau, while Mahadeo, Kaimur, and Maikal are the important hills of the Chhota Nagpur plateau. The valley of Narmada lies between the Vindhyas and the Satpura, which flows east in a rift valley to west and joins the Arabian sea.

b. **The Deccan Plateau:** The Deccan plateau is separated by a fault (A fracture in the rock along which rocks have been relatively replaced) from the Chhota Nagpur plateau. The black soil area in the Deccan plateau is known as the Deccan trap. It is formed due to volcanic eruptions. This soil is suitable for cotton & sugarcane cultivation. The Deccan plateau is broadly divided into (i) The Western Ghats and (ii) The Eastern Ghats.

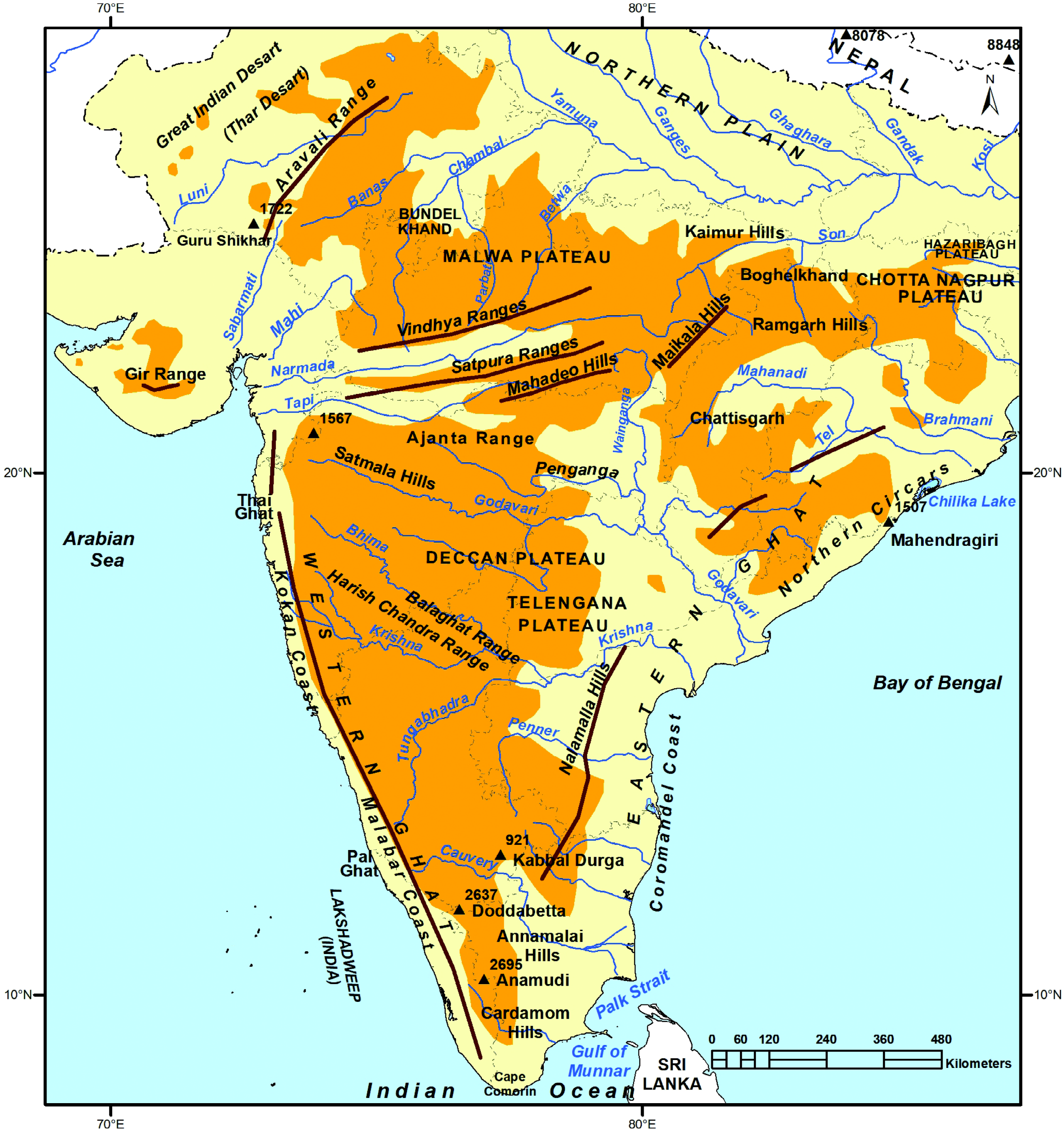


Fig. 11.4: The Peninsular Plateau

(i) The Western Ghats: If we look at the map, we will see the Western Ghats or Sahyadris lie on the Western edge of the Deccan plateau. It runs parallel to the western coast for about 1600 km. The average elevation of the Western Ghats is 1000 metres. The famous peaks in this area are Doda Betta, Anamudi, and Makurti. The highest peak in this region is Anaimudi (2695m.). Western ghats are continuous and can be crossed through passes like Pal Ghat, Thal Ghat, and Bhor Ghat. The rivers like the Godavari, Bhima, and Krishna flow eastward, while the river Tapti flows westward. The streams form many rapids and water falls in Western Ghats. The famous waterfalls are Jog Falls on Sharavathi, Shiva Samudram falls on Kaveri, etc.

(ii) The Eastern Ghats: The Eastern Ghats are discontinuous low belts. Their average elevation is 600 m. They run parallel to the east coast from the south of Mahanadi valley to the Nilgiri hills. The highest peak in this region is Mahendragiri (1501 m). The famous hills are Mahendragiri hills, Niyamgiri hills in Orissa, Nallamala hills in Southern Andhra Pradesh, Kollimalai, and Pachaimalai in Tamilnadu. The Mahanadi, Godawari, Krishna, and Kaveri river systems drain the area and fall into the Bay of Bengal. The Nilgiri hills join the Western and Eastern Ghats in the south.

INTEXT QUESTIONS 11.4

1. Select the correct alternatives:

   i. Which river flows through a rift valley?

      a. Chambal

      b. Yamuna

      c. Godavari

      d. Narmada

   ii. Which is the highest peak of Aravallis?

      a. Gurushikhar

      b. Anamiudi

      c. Mahendragiri

      d. Doda Betta

2. Name any three important rivers of Malwa plateau.

3. Which is the highest peak of Southern India?

D. The Indian Desert

To the northwest of the Aravali hills lies the Great Indian desert. It is a land of undulating topography dotted with longitudinal dunes and barchans. This region receives low rainfall below 150 mm per year; hence, it has an arid climate with low vegetation cover. It is because of these characteristic features this is also known as Marusthali. It is believed that this region was under the sea during the Mesozoic era. It can be corroborated by the evidence available at the wood fossils park at Aakal and marine deposits around Brahmsar, near Jaisalmer (The approximate age of the wood fossils is estimated to be 180 million years). Though the underlying rock structure of the desert is an extension of the Peninsular plateau, due to extremely arid conditions, its surface features have been carved by physical weathering and wind actions. Some well-pronounced desert land features are mushroom rocks, shifting dunes, and an oasis (mostly in its southern part). Based on the orientation, the desert can be divided into two parts: the northern slopes towards Sindh and the south towards the Rann of Kutch.

Most of the rivers in this region are ephemeral. The Luni river flowing in the southern part of the desert is of some significance. Low precipitation and high evaporation make it a water-deficit area. Some streams disappear after flowing for some distance and present a typical case of inland drainage by joining a lake or playa. The lakes and the playas have salty water, the primary source of salt.

E. The Coastal Plains

The Great Plateau of India is surrounded by plains on all sides. In the north lies the Great Northern Plain, and in the south, along the east and west, lie the Coastal Plains.

a. **The East Coastal Plain:** It extends along the coast of the Bay of Bengal from Ganga Delta in the north to Kanyakumari in the south. This plain is broader than the western coastal Plains. This plain includes the deltas of the rivers Mahanadi, Godavari, Krishna and Kaveri. Chilka, Pulicat, and Kollur lakes are the famous lagoons of this plain. These lakes have been formed by enclosing small parts of the Bay of Bengal behind sand bars. Lake Chilka is situated south of the delta of Mahanadi. The lake measures 75 km in length. Lake Pulicat is situated north of Chennai city. Koluru lake is situated between the deltas of the Godavari and Krishna rivers. The east coastal plain is fertile, where rice grows in abundance.

b. **The West Coastal Plain:** It extends along the Arabian Sea from the Rann of Kutch in the north and to Kanyakumari in the south. Except for the Gujarat plain, the western coastal plains are narrower than the eastern coastal plain. From southern Gujarat upto Mumbai, this plain is comparatively broader, but it narrows southwards of Mumbai. Occasionally rocky domes and hills are visible in the plains of Gujarat,

the Rann of Kutch, and the plains of Kathiawar. The plains of Gujarat are made up of black soil. The coastal strip extending for about 500 km between Daman in the north and Goa in the south is called Konkan. This region is highly dissected, and the coastline is indented or irregular with several natural harbours. Several small and seasonal rivers flow through this region. The coast from Goa to Mangalore is called the Karnataka coast. The coast from Mangalore upto Kanyakumari is called the Malabar coast. Here the coastal plain is wider. There are a number of long and narrow lagoons. Eighty kilometres long,Vembanad is an example of its kind. Kochi port is situated on one of the lagoons.

F. Indian Islands

There are two small groups of islands. One of these, situated in the Bay of Bengal off the coast of Myanmar, is known as the Andaman and Nicobar Islands. The other is known as Lakshadweep and is situated in the Arabian Sea, off the coast of Kerala. The Andaman Islands consist of (i) North, (ii) Middle, (iii) South, and (iv) Little Andaman Islands. Port Blair is the capital city of the entire Union Territory and is located on South Andaman Island. The Ten Degree Channel separates this island group. To its south are situated the Nicobar Islands. They include Car Nicobar, Little Nicobar, and Great Nicobar Islands from north to south. The southernmost point of the Indian Union lies on Great Nicobar Island and has been named after Indira Gandhi. These islands represent a submerged chain of mountains. The Barren Island in the Andamans is India's only active volcano. These islands act as naval and air outposts of our country because of their strategic location. This island group faces seven countries - Bangladesh, Myanmar, Thailand, Malaysia, Singapore, Indonesia, and Sri Lanka.

Lakshadweep Islands are situated in the Arabian Sea, off the coast of Kerala. All these islands are of coral origin. They have been built up by corals, the microscopic polyps. All these islands are very small in size. The largest island among these, the Minicoy, only has an area of 4.5 square km. Kavaratti is the capital city of this island group.

INTEXT QUESTIONS 11.5

1. Fill in the blanks:

   i. Koluru lake is situated between the deltas of the …….. and …………. rivers.

   ii. The plains of Gujarat are made up of ………… soil.

   iii. The significant river of the Indian desert is …………..

Notes

2. Name any three famous lagoons of east coastal plain.

3. Which is the largest island of Lakshadweep Islands?

11.3 DRAINAGE SYSTEM OF INDIA

The drainage pattern or system of an area refers to the system of flow of surface water, mainly through the rivers and basin forms. The drainage system studies streams and the directions in which they carry the surface water of an area. The drainage system is related to a number of factors, for example, the slope of the land, geological structure, amount of water volume, and water velocity. Several small and large rivers carry India's surface runoff. The country's drainage system can be studied with reference to two parts: Northern India and Southern India.

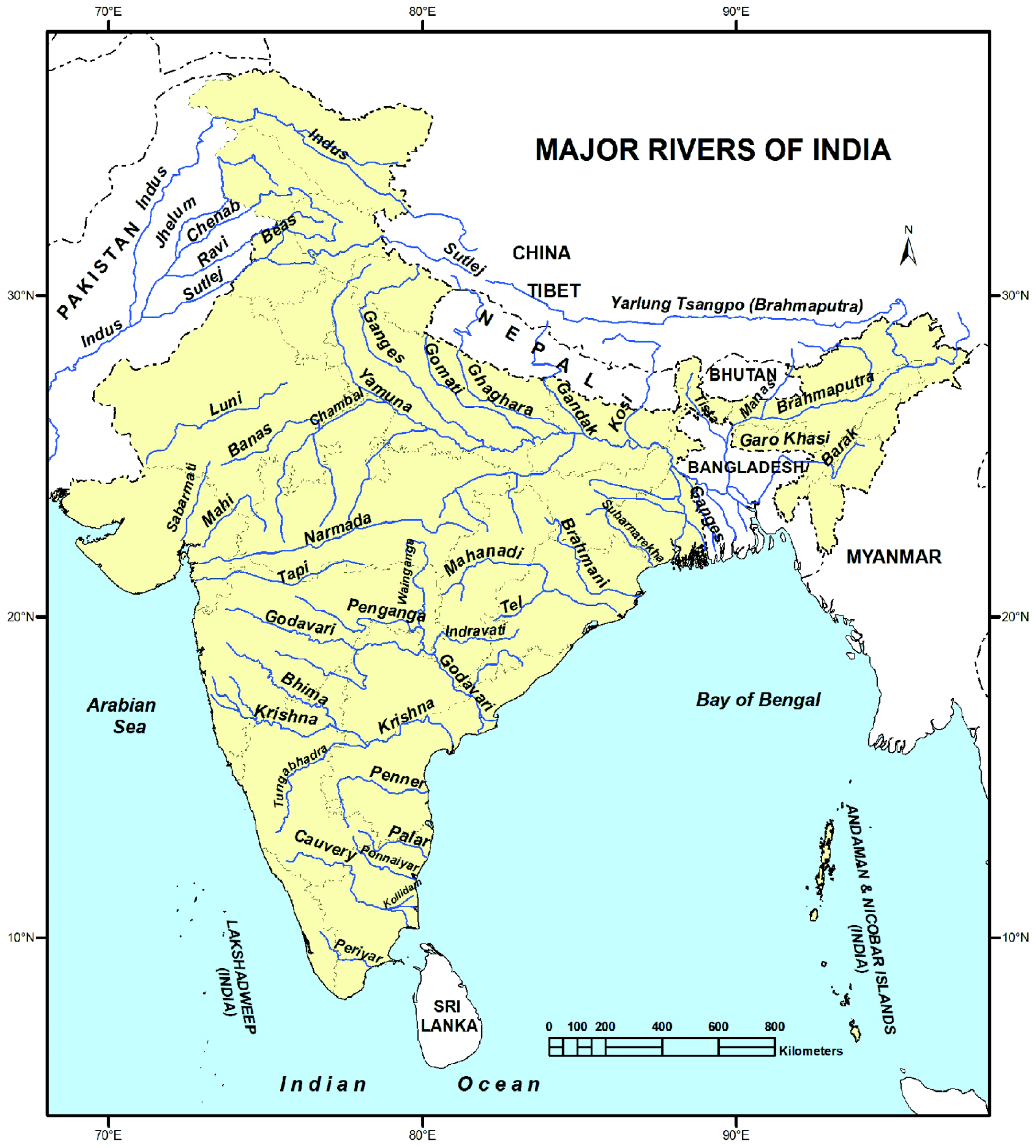


Fig. 11.5: Major Rivers of India

Notes

A. Drainage System of North India

The Himalayas play an essential role in the drainage system of North India. It is because the rivers of North India have their sources in these mountains and beyond. These rivers differ from South India's as they still rapidly deepen their valleys. The debris eroded by these rivers is carried to the plains and seas and deposited there. This deposition is caused by the reduced velocity of river waters in the plains and deltas for want of necessary slope.

The Great North Indian plain has been formed by the silt brought down by these rivers. Some of the Himalayan rivers are older than the Himalayas themselves. As the ranges of the Himalayas had been rising upwards, these rivers were equally busy in downward cutting, forming deep gorges and valleys. Consequently, parts of the valleys of these rivers are very deep, and gorges have been formed. The depth of the Indus gorge near Bunji (Ladakh) is 5200 metres. Sutlej and Brahmaputra have also formed such gorges.

The drainage system of Northern India can be further subdivided into three subsystems: Indus System, Ganga System, and Brahmaputra System.

The major rivers of the Indus basin are the Indus, Jhelum, Chenab, Ravi, Beas, and Sutlej. The Ganga basin includes Ramganga, Ghagra, Gomti, Gandak, Kosi, and Yamuna and its southern tributaries, Son and Damodar rivers. The major rivers of the Brahmaputra basin are Dibang and Lohit in Arunachal Pradesh and Assam, Tista in Sikkim, West Bengal and Bangladesh, and Meghna, draining the north-eastern part of Bangladesh.

B. Drainage System of Southern India

Peninsular India is an ancient landmass. Therefore, the streams flowing through this region are in their old stage. They have almost attained their base level of erosion. Their capacity to erode valleys vertically has nearly come to a negligible stage. Now, these streams are eroding their sides at a slow pace. This results in the broadening of their valleys.

Consequently, during floods, their waters spread over a large area. It is believed that the Peninsular block had a slight tilt towards the east due to the time of Himalayan orogeny due to the movements associated with the mountain-building processes. This is why, barring Narmada and Tapi, all the major rivers of south India flow towards the east. Narmada and Tapi both flow through fault or rift valleys. The major rivers of the drainage system of southern India are Mahanadi, Godavari, Krishna, Pennar, Kaveri, and Vaigai.

The slope of the northern part of the southern peninsula is towards the north. Consequently, some of the streams originating in the Vindhyas flow north and join Yamuna and Ganga. Chambal, Ken, Betwa, Sind, and Son are more important among these.

The difference between the Himalayan rivers and Peninsular rivers:

The rivers which have their origin in the Himalayas are perennial. These rivers are fed by the melting of ice and snow lying near the tongue of glaciers of the Great Himalayan Range (Himadri).

In the rivers of South India, the flow of water is highly fluctuating. While the rivers are in spate during the monsoons, they are almost dry during the long rainless months. Some of these rivers, in many places, become dry.

11.4 UNITY IN DIVERSITY IN INDIA

India possesses a wide variety of landforms and relief features. Its young fold mountains of the north have very bold and sharp features. They include long and tall mountain ranges, towering mountain peaks, high mountain passes, and precipitous river valleys. If in one direction lie very steep slopes, in the other, there are gentle slopes. If some parts are without thick forests, the others are clad with varied natural vegetation - from tropical rainforests to Alpine grasslands. They rightly boast of large snowfields, glaciers, picturesque waterfalls along the hanging valleys, and glacial lakes like the Dal in Srinagar. The youthful Himalayan rivers prefer to jump, leap and hop, forming waterfalls, rapids, and cascades on their way. Equally awe-inspiring are its deep gorges establishing a balance between steadily rising mountain ranges on the one hand and the silent down-cutting action of weighty trans-Himalayan rivers like the Indus, Sutlej, and Brahmaputra on the other. Not even a handful of countries can boast of such a majestic and maddening beauty of youthful fold mountains. These world's highest and largest mountain chains have enabled the Indian subcontinent to develop its unique culture by acting as a physical barrier between the subcontinent and the rest of Asia. Perhaps even more compelling is its role as a climatic divide. This physiographic division acts as a storehouse of snow and water, giving rise to hundreds of perennial rivers to drain and irrigate one of the world's largest and most fertile plains. In fact, the plains themselves are a gift of these mountains and rivers flowing from them. It is also a storehouse of hydel power, fuel wood, timber, various forest products, and medicinal herbs, not excluding some strange wildlife species. No wonder this region can attract tourists from far and near, both in summer and winter.

The Northern Plains are matchless in the expanse. These flat or dead-level plains are mostly well-drained and fairly well-irrigated through surface and groundwater. The meandering rivers, oxbow lakes, braided river channels, and a maze of distributaries help to break the monotony of these extremely level plains. Once a forest land, it has been brought almost entirely under the plough. The lower parts of the deltas are ribboned with mangrove or tidal forests. These well-watered plains, supported by highly fertile soils, produce varied crops yearly, sustaining a large chunk of the world's population. They have also been keeping an equally large bovine population. They are one of the world's largest food baskets producing cereals, pulses, oil

seeds, vegetables, and fruits, besides industrial or cash crops like cotton, jute, sugarcane, and the like.

In sharp contrast with the Northern Mountains and Plains stand the hills of moderate altitude and a highly denuded rocky landscape, representing one of the oldest landmasses of the world - the peninsular block of India. Its rounded hills and flat-topped ridges have a beauty of their own. The varied metamorphic and old granite rocks have given rise to hills, plateaus, and foliated rocks. Furthermore, the basalt or Deccan Trap of Western India has its typical flat-topped hills and that or hairlike structures. Its steep wall-like escarpments run miles without interruption overlooking the Arabian Sea. Their beauty needs to be seen and to be believed. This physiographic division is known for millets and various industrial crops such as cotton, sugarcane, coffee, and groundnut. More importantly, it is a storehouse of minerals - mainly the ferrous ones and mineral fuels like coal and atomic or radio-active minerals. They also have sizable hydel power resources. They, thus, provide a sound base to develop both agro-based and mineral-based industries.

The coastal strips are ribboned with a partly regular and indented coastline. The latter has provided spacious natural harbours like Mumbai and Marmagao. The coastal strips and island groups have ideal conditions to tap deep and shallow water fisheries. The coastal plains in the east have very fertile deltas providing rice bowls. If it is a coast of emergence on the eastern coast, then the major part of the western coast is that of submergence. The plains are rocky and highly eroded. Rice, coconuts, rubber, tobacco, and spices are some of the agricultural produce. Off-shore oil and natural gas fields have also been located. If the Lakshadweep are of coral origin, the Andaman and Nicobar Islands are the peaks of the emerging mountain chain. These islands are of great strategic significance to the defence of the mainland. They face seven countries across the seas washing their shores - Bangladesh, Myanmar, Thailand, Malaysia, Singapore, Indonesia, and Sri Lanka. The islands are known for fishing, forestry, and tourism.

In this way, the enormous variety of macro- and micro-relief features and landforms has enriched our culture, improved agricultural potential to grow almost every crop, laid strong foundations for the modern industry, making all of its physiographic divisions interdependent on one another, and contributed to the unity in diversity in our Bharat.

Notes

INTEXT QUESTIONS 11.6

1. Fill in the blanks:

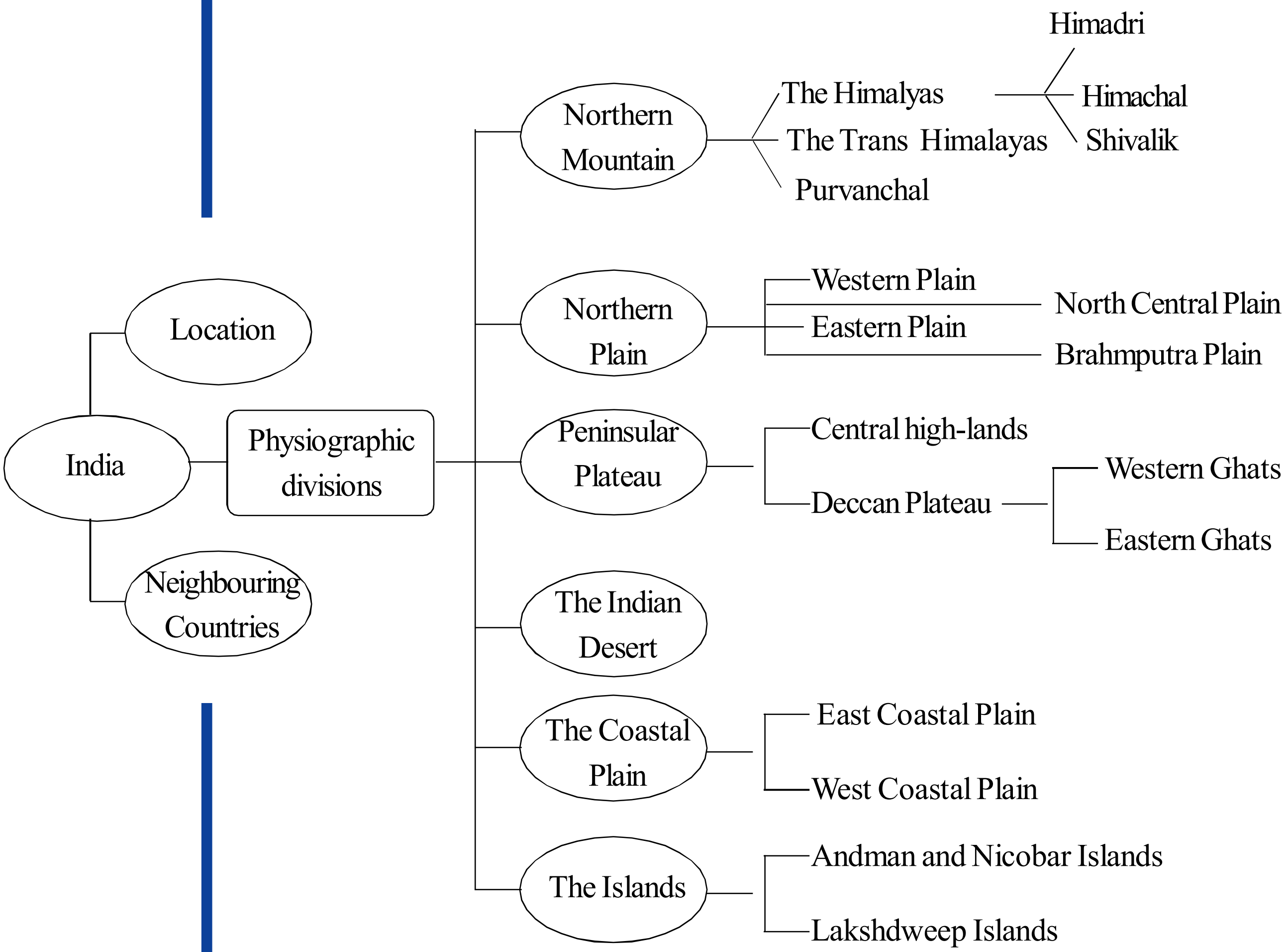
   i. The depth of the Indus gorge near Bunji (Ladakh) is .... metres.

   ii. Son is the southern tributary of ....

2. Name the drainage system of Northern India.

3. Name any three rivers of the southern drainage system.

WHAT YOU HAVE LEARNT



TERMINAL QUESTIONS

1. Give a brief account of the Himachal Range under the following headings.

   a. Location

   b. Their average height and length

   c. A few major peaks

   d. Few prominent glaciers and

   e. Major hill towns

2. Differentiate between:

   a. Western ghat and Eastern ghat.

   b. The Himalayan rivers and peninsular rivers.

3. Divide the Northern Plain into four physiographic divisions and describe briefly the eastern plain.

4. Describe briefly the key features of the eastern coastal plain.

5. Write a brief description of the Indian Islands.

6. Define the following -

   a. Standard Meridian of India

   b. Drainage System

7. Locate the following in the outline maps of India.

   a. Himadri

   b. Karakoram

   c. Pir Panjal Range

   d. Ladakh Range

   e. Satpura and Vindhyachal Range

   f. Satluj river

g. Ganga river

h. Mahanadi river

i. Godavari river

j. Kaveri river and

k. Narmada river

ANSWERS TO INTEXT QUESTIONS

11.1

1. i. 8°4'N, 37°6'.

   ii. Indira Point

   iii. Standard

   iv. 15,200

2. Answer the following questions in one word or a sentence.

   i. Tropic of Cancer

   ii. Approx 2 hours

   iii. Indira Point.

11.2

1. Himadri, Himachal and Shivalik

2. Mt. Everest

3. Fill in the blanks:

   i. Pir Panjal, Himadri ranges

   ii. Himachal

   iii. Zaskar, Ladakh

11.3

1. The relatively higher part of the plain is called Bangar while the comparatively lower area is called the khaddar.

2. (i) Western plain,

   (ii) North Central plain,

   (iii) Eastern plain, and

   (iv) Brahmaputra plain.

3. Fill in the blanks:

   i. Terai

   ii. Sambhar

   iii. River Ganga

   iv. Majuli

11.4

1. Select the correct alternatives:

   i. d. Narmada

   ii. a. Gurushikhar

2. Betwa, Chambal, and Ken

3. Anamudi

11.5

1. Fill in the blanks:

   i. Godavari and Krishna

   ii. Black

   iii. Luni

2. Chilka, Pulicat, and Koluru

3. Minicoy

Notes

11.6

1. Fill in the blanks:

   i. 5200

   ii. Ganga

2. Perennial

3. Narmada, Tapi, Godavari, Krishna, Kaveri etc (Any three)

12

CLIMATE

You have studied India's shape, size, location, and latitudinal extent in previous lesson . You have also learnt that how India's relief characteristics contrast strikingly. These variations have led to climatic variations between regions. The climatic conditions in southern India differ slightly from those in the northern regions.

Now, let us have a closer look at these climatic variations. During Summer, the north-western plains experience high temperatures around 45°C while areas of the Rajasthan desert may record day temperatures around 55°C. At the same time the temperatures around Gulmarg or Pahalgam in Kashmir are hardly around 20°C. Similarly, in December, the people of Kargil or Dras (in Ladakh, UT) experience biting cold because the night temperatures drop to -40°C, while the inhabitants of Thiruvananthapuram experience temperatures around 27° C.

In this lesson, we will look for several variables that contribute to these climatic fluctuations through time and space.

OUTCOMES

After studying this lesson, learner:

- describes the factors that influence the climate;
- explains the mechanism of monsoon and its significance in the Indian economy;
- becomes familiar with the seasons; and
- describes the distributional patterns of temperature and rainfall.

12.1 FACTORS INFLUENCING THE CLIMATE OF INDIA

You may have observed the diversity in Indian climatic conditions while visiting to different places. Such diversity is possible due to various factors influencing the climate of India. These factors are:

A. Location and Latitudinal Extent

India is located roughly between latitudes 6°N and 37°N. The Tropic of Cancer passes through the middle of the country. Due to their proximity to the equator, the southern regions have hot temperatures all year round. On the other hand, the northern regions are located in warm temperate regions. They consequently endure cold conditions, especially throughout the winter. The climate is milder near the coast of peninsular India because of the water bodies surrounding it.

B. Distance from the Sea

Southern or peninsular India is surrounded by the Arabian Sea, the Indian Ocean, and the Bay of Bengal. Hence the climate of coastal regions of India is equable or maritime. The climate of the regions in the country's interior is cut off from the oceanic influence. As a result, they have an extreme or continental type of climate.

C. The Northern Mountain Ranges

India and the rest of Asia are divided by the Himalayan and nearby mountain ranges, which stretch from Kashmir in the north west to Arunachal Pradesh in the north east. During winter, these hills shield India from the savagely chilly and dry winds of Central Asia. Additionally, they serve as a strong physical barrier that prevents rain-bearing southwest monsoon winds from entering India's northern borders. These ranges act as a climate barrier between Central Asia and the Indian Subcontinent.

D. Physiography

In various regions of the nation, physical characteristics affect the air temperature, atmospheric pressure, wind speed, and rainfall. Look at the physical feature map of India from the previous lesson, and using the climatic maps from this lesson, determine for yourself the link between the relief, temperatures, wind direction, and rainfall amounts. It will clarify why the interior regions of Karnataka and Tamil Nadu, located east of the Western Ghats, have less rainfall than the western coastal plains. Additionally, you will comprehend why the Bay of Bengal branch of the South west monsoon splits into two portions, one travelling down the Ganga Valley to the west and the other along the Brahmaputra Valley to the east.

E. Monsoon Winds

The complete reversal in the direction of winds over India brings about a sudden change in seasons - the harsh summer season suddenly giving way to the eagerly awaited monsoon or rainy season. These winds, which change their direction completely, are called monsoon winds. The word 'monsoon' is derived from the Arabic word 'Mousim,' which means 'season.' These winds have such a far-reaching influence on India's climate

Notes

that it is termed a 'monsoon type of climate.' The nature of these winds can be described concerning the surface distribution of pressure in different regions of India during the winter and summer seasons.

(a) **The North east Monsoon and its Effect:** During winter, the weather conditions are influenced by high pressure developed over the Northw estern subcontinent. It results in blowing cold, dry winds from this region towards southern low-pressure areas lying over water bodies surrounding peninsular India. Since these winds are cold and dry, they do not cause rainfall, and weather conditions under their influence remain cold and dry. However, wherever these North east monsoon winds collect moisture while passing over the Bay of Bengal, they bring rain along the Coromandel Coast. Strictly speaking, these winds are planetary winds known as Northeast Trades. In India, they are essentially land-bearing winds.

(b) **The South west Monsoon and its Effect:** During summer, the northwestern parts of India become very hot due to high temperatures. It is ascribed to the apparent shift of the sun in the northern hemisphere. It results in the reversal of air pressure conditions in north western India and water bodies surrounding the peninsular plateau. As a result, North east Trade winds are replaced by South west monsoon winds. Since these winds are sea-bearing and blow over warm water bodies before reaching land, they are moisture-laden, causing widespread rain over most parts of India. This period of the south west monsoon, from June to September, is known as the rainy season for most parts of the country.

F. Upper-Air Circulation

The changes in the upper air circulation over the Indian landmass are yet another cause for the sudden outbreak of monsoons in India. Jet streams in the upper air system influence the climate of India in the following ways:

(a) **The Westerly Jet Stream and its Impact:** During winter, at about 8 km. above sea level, a westerly jet stream blows at a very high speed over the subtropical zone. The Himalayan ranges bifurcate this jet stream. This jet stream's northern branch blows along the northern edge of this barrier. The southern branch blows eastwards south of the Himalayan ranges along 25° N latitude. Meteorologists believe that this branch of the jet stream significantly influences India's winter weather conditions. This jet stream is responsible for bringing western disturbances from the Mediterranean region into the Indian subcontinent. Winter rain and hail storms in north western plains and occasional heavy snowfall in hilly regions are caused by these disturbances. Cold waves generally follow these in the whole of the northern plains.

(b) **Easterly Jet and its Influence:** Due to the apparent shift of the sun in the northern hemisphere during the summer, the upper air circulation is reversed. The easterly jet stream, created due to the Tibetan plateau's heating, takes the place of the westerly stream. It caused the formation of an easterly, chilly jet stream that was blowing over peninsular India and was focused at 15°N latitude. It aids in the monsoons' quick arrival.

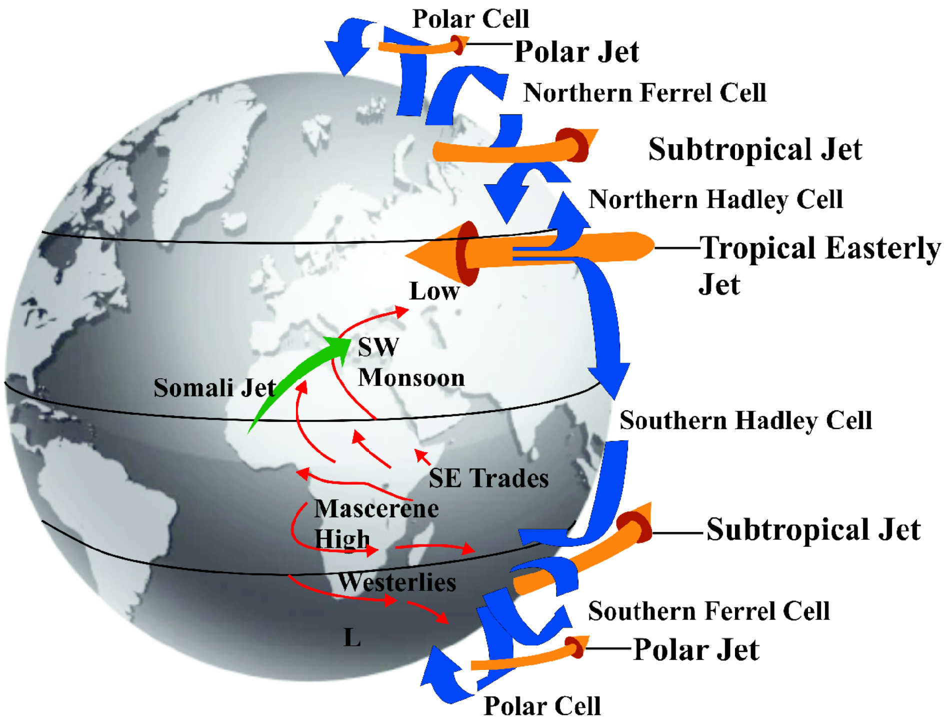


Fig. 12.1 Upper-Air Circulation

G. Western Disturbances and Tropical Cyclones

Westerly jet streams from the Mediterranean Sea impact the entrance of western disturbances. It affects most of the Northern Plains and Western Himalayan region's winter weather conditions. In the winter, it doesn't rain much. The northern plains' wheat harvests are thought to benefit significantly from this rain.

Additionally, the Bay of Bengal is where tropical cyclones form. In October, November, and December, these cyclones' frequency and trajectory have an impact on the weather along the eastern coast.

Notes

Fig. 12.2 Emergence of Western Disturbances

H. El - Nino Effect

Weather conditions in India are also influenced by EI-Nino, which causes widespread floods and droughts in tropical regions of the world. El-Nino is a narrow warm current that sometimes appears off the coast of Peru in South America. It is a temporary replacement for the cold Peru current, which generally flows along this coast. Sometimes, becoming more intense, it increases the surface water temperatures of the sea by 10° C. This warming of tropical Pacific waters affects the global pattern of pressure and wind systems, including the monsoon winds in the Indian Ocean. It is believed that EI-Nino caused the severest drought of 1987 over India.

I. Southern Oscillation and its Effect

The southern oscillation is a pattern of meteorological changes often observed between the Indian and Pacific oceans. It has been noticed that whenever the surface level pressure is high over the Indian Ocean, it is low over the Pacific Ocean and vice-versa. When the pressure is increased over the Pacific Ocean and low over the Indian Ocean, the South west monsoons' in India tend to be weaker. In the reverse case, the monsoons are most likely to be stronger.

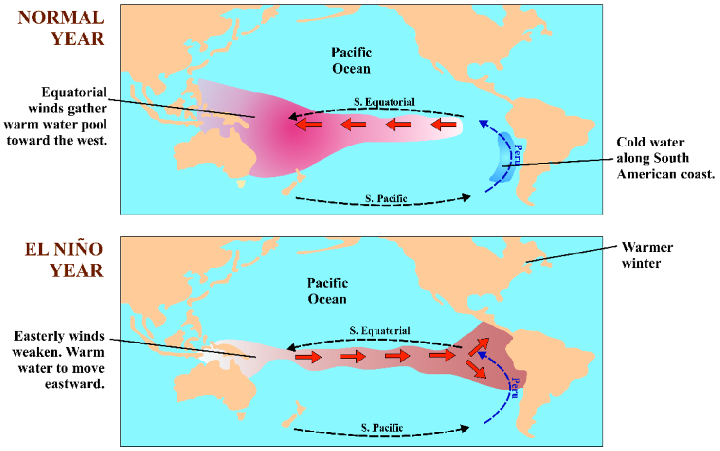


Fig. 12.3 The El Nino Phenomenon

INTEXT QUESTIONS 12.1

1. Name any three factors influencing the climate of India.
2. Name the current appearing off the coast of Peru.
3. Fill in the blanks:
   i. The word 'monsoon' is derived from the Arabic word ....
   ii. The tropical cyclones form in ....
   iii. The jet stream is bifurcated by.............

12.2 MECHANISM OF MONSOON

The term "monsoon" describes a tropical wind pattern in which the direction of the wind entirely changes from summer to winter. In this system, the winds alternate between winter and summer directions, blowing from land to sea. As a result, the monsoon-influenced regions receive most of their rainfall throughout the summer, while the winter is often dry.

According to traditional belief, the monsoon is caused by the differential heating of land and sea. Due to a higher temperature over the land in summer, a low-pressure area develops over the continents, and the winds blow from neighbouring oceans toward the land. These winds are of maritime origin and hence cause ample rainfall in summer. On the other hand, the continents become colder than the neighbouring oceans in winter. As a result, a high-pressure area is developed over the continents. Therefore, winds blow from land to sea in winter. These winds, being of continental origin, are dry and do not cause rain. This traditional theory of the monsoon has been criticised by the German meteorologist Flohn. He argues that the differential heating of land and sea is not enough to cause a seasonal reversal of winds at a global scale. He has explained the origin of the monsoon on the basis of the seasonal shift of the pressure and wind belts under the influence of the shift of the sun's vertical rays.

According to this theory, as the sun's vertical rays shift northwards over the Tropic of Cancer in the summer season, the Inter-Tropical Convergence Zone (ITCZ) also moves to the north. It forms a low-pressure area over the northwestern parts of India. The high temperatures in this region further intensify this low pressure. This low-pressure area sucks the air from the Indian Ocean towards the Indian landmass in the form of South west monsoons. In the winter, the ITCZ shifts southwards, and a mild high pressure is produced over northern parts of India. This high pressure is further intensified by the equatorward shift of the sub-tropical high-pressure belt. Due to high pressure over north India, the winds start blowing from the northeast as retreating monsoons. According to recent observations, the origin of the Indian monsoon is influenced by several other factors besides the differential heating of land and sea and the seasonal shifts of pressure and wind belts.

One of the most important factors is the sub-tropical westerly and tropical easterly jet streams. The sub-tropical westerly jet streams blowing over India in winter cause high pressure over northern India. It thus intensifies the northeast monsoons. This jet stream shifts northwards beyond India in the summer season, and tropical easterly jets develop over India in this season. The behaviour of these jet streams is partly responsible for the variations in the time of onset of south west monsoons over India.

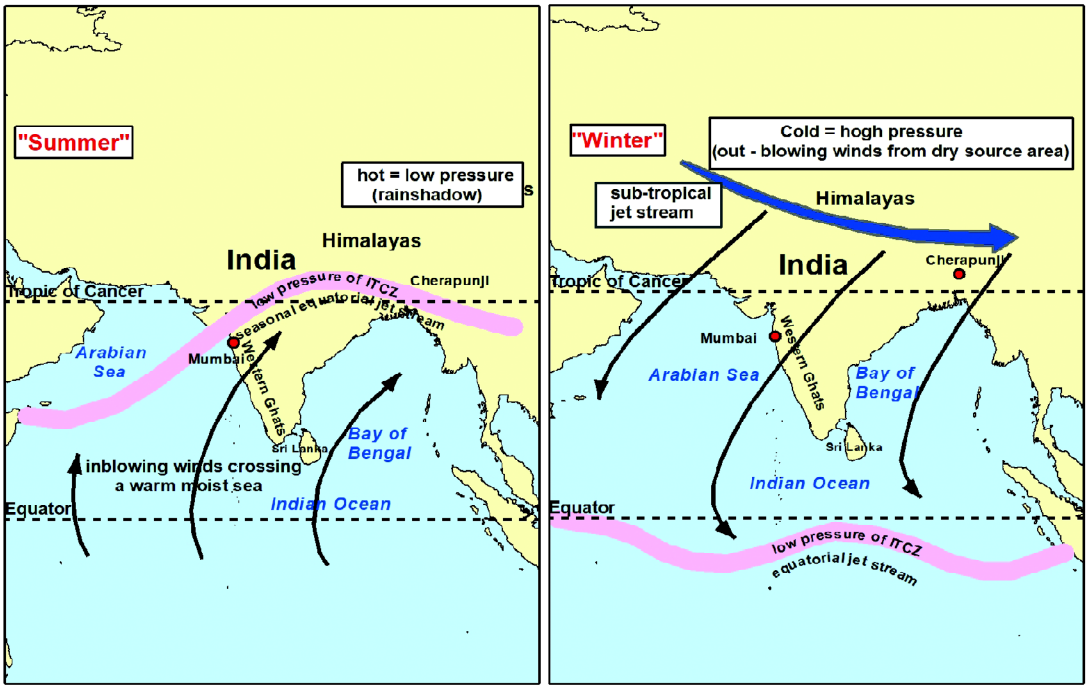


Fig. 12.4 Mechanism of Monsoon

Significance of monsoon in the Indian economy

The Indian climate is called the 'monsoon climate.' It explains how much influence the monsoon winds have in bringing climatic unity. This unity in climatic conditions results from the combined influence of regular movements of monsoons (seasonal winds) and the bounding role of the Himalayan mountain system.

The monsoonal unity of India caused by these twin factors is discernible. It reflects upon the lifestyles and activities of the common masses in India. The sequence of hot, wet, and cold seasons affects the lifestyles and economic activities of the people throughout India in the following ways:

Farmers all over India start their agricultural activities like ploughing fields, sowing seeds, transplantation, etc., with or just before the onset of monsoons. Kharif crops - rice and millet, cotton and sugarcane in different areas- express the amount of rainfall they receive. During winter, wheat is the major rabi crop in cool and irrigated areas, whereas barley, gram, and oil seeds are common crops in unirrigated regions of northern and central India.

Clothes are also affected by the seasons. During summer, people wear cotton clothes, whereas woollen clothes are used in the winter, especially in the north and central India.

- Most parts of India have to bear a long dry season; on the contrary, the season of life-giving rains is limited to only a few months. It has a far-reaching effect on the lifestyle of the Indian people. The monsoon clouds fall on the thirsty parched land. Their music and fragrance come out of the land to generate similar emotional responses all over India. It is reflected in the Kajari of Bhojpuri and Malhar of Brij and their counterparts in other regions of India. Most Indian festivals are closely linked with seasons. In north India, Baisakhi is celebrated when the rabi crop is ready for harvesting. During winter, when the sun shines vertically over the Tropic of Capricorn, and extremely cold weather conditions prevail over the northern plains, Lohri and Makar Sankranti are celebrated in the north and west. At the same time, Pongal distinctly is its southern counterpart. Holi is celebrated in spring after bidding goodbye to the prolonged cold winter, especially in the north.
- Rainfed subsistence farming has been the oldest response of the village community. Its entire economy is based on it, however meagre rain it may be.
- The seasonal and regional variations in weather conditions have made different regions capable of producing different crops in varying quantities making all regions completely interdependent. This is not a contribution of the monsoons in promoting underlying unity despite all pervasive diversity.

INTEXT QUESTIONS 12.2

Fill in the blanks:

1. The traditional theory of the monsoon was criticised by the German meteorologist ……...
2. ………… is the major rabi crop during winter.
3. During summer, people wear … clothes, whereas …… clothes are used in the winter.

12.3 CYCLE OF SEASONS IN INDIA

By now, you have understood that the complete reversal of the direction of winds is the most striking feature of monsoons. These changing monsoon winds result in the change of seasons over the year. It is, therefore, essential to understand, in detail, the prevailing weather conditions throughout India during different seasons.

Climatically, the year is divided into the following four seasons in India:

i. The cold weather season - December to February;

ii. The hot weather season - March to May in the south and up to June in the north;

iii. The advancing south west monsoon season - June to September;

iv. The retreating southwest monsoon season - October and November.

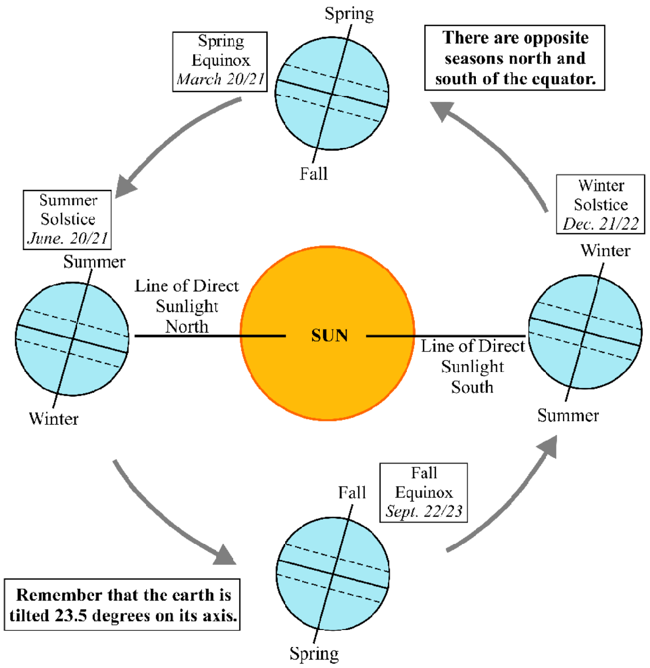


Fig. 12.5 Cycle of Seasons

i. The Cold Weather Season

In northern India, this season often starts in late November. As the sun shines vertically over the Tropic of Capricorn in the southern hemisphere, January is the coldest month for most of the nation. Over northern plains and mountain regions, the typical daily temperatures during these months stay below 21°C. Sometimes the night time lows are below freezing, which causes widespread frost damage to the standing crops. As one travels from the north to the south, the temperature rises. Low temperatures cause a weak high-pressure region to form over areas of northern India. This modest high pressure brings on the off-shore North east monsoon winds. Due to the relief, they are moving westward on the Northern Plains. These chilly breezes carry dry cold winds.

The succession of depressions is another feature of this season. These low-pressure systems are called "Western disturbances" as they originate in the Mediterranean region. These depressions move with the westerly jet streams. Covering a long distance over Iraq, Iran, and Pakistan, they reach India around mid-December. Their arrival results in the increase of temperature and light rains over northern plains. They cause widespread snowfall over the western Himalayas and the adjoining ranges. At times hailstorms cause widespread damage to the standing rabi crops in north western plains. The meagre rainfall caused by these disturbances is essential to the standing crops, particularly wheat, in irrigated areas. These depressions are followed by cold waves, which bring down temperatures considerably.

Peninsular India has no well-defined winter season. The mean monthly temperatures in January are above 20°C in this part. Moreover, the coastal plains hardly experience any seasonal change, as is clear from the mean monthly temperature above 27°C at Thiruvananthapuram. But Chennai records a temperature of 25°C during December and early January owing to the rains caused by North east monsoon winds.

The essential characteristics of cold weather season are:

- Low temperatures in the north and their gradual increase towards southern parts of India.
- The blowing of cold and dry northeast monsoon resulted in dry weather conditions in most parts. Coromandel coast receives rainfall during winter.
- Western disturbances cause light rain in the northern plains and snowfall over the Himalayan ranges.

ii. The Hot Weather Season

The sun's apparent movement towards the north increases the temperatures in the northern plains. As a result, spring sets in soon, giving way to the hot weather season, which lasts till the end of June in this region. The temperatures increase northwards and reach around 45°C in mid-May in most parts of the northern plains. The characteristic features of this season are afternoon dust storms and 'Loo,' a hot, dry wind that blows during May and June, mainly over the northern plains. These winds cause heat stroke resulting in the deaths of hundreds of people every year. The day temperatures rise above 45°C in some northwestern parts of the country.

During this season of the year, the wind direction changes. Generally speaking, the nation has hot and dry weather. However, on the Northern Plains, dust storms result in rain. Also seeing light rains are West Bengal, Assam, and Kerala. These pre-monsoon showers are referred to as "Mango Showers" in Kerala. They are referred to as

Northwesters or 'Kal Baisakhi' in West Bengal and Assam. Sometimes these Northwesters inflict significant loss of life and property because of the tremendous wind speeds.

iii. The Advancing South west Monsoon Season

It is the rainy season for most parts of India. It starts with the inflow of Southwest monsoons which generally strike the coast of Kerala in the first week of June and cover most of India by mid-July. This weather continues till September. The arrival of these warm, moisture-laden winds brings a total change in weather conditions. Their arrival causes sudden rains, which bring down the temperatures considerably. The decline in temperature is between 5°C to 10°C. The sudden onset of rain is called a break of monsoons or a burst of monsoons. The arrival of these winds may be delayed by a week or two depending upon the pressure conditions over the northern plains and the Indian ocean. The peninsular shape of India divides these Southwest monsoons into two branches - the Arabian Sea branch and the Bay of Bengal branch.

(a) Arabian Sea branch of South west monsoons strikes the western coast of India and causes heavy rains on the western slopes of the Western Ghats. After crossing the Western Ghats, these winds cause less rainfall on the eastern slopes as they gain temperature while descending. This area is, therefore, known as the rain shadow zone. It explains why interior parts of Maharashtra, Karnataka, and Telangana get light rains from these winds. South west monsoons strike along the coast of Saurashtra and Kuchchh and pass over Rajasthan and beyond to meet the Bay of Bengal branch. These winds cause widespread rain in these states and the western Himalayan region.

(b) After encountering the eastern Himalayas, the Bay of Bengal branch splits into two sub-branches. One branch goes in an east-northeasterly direction, causing heavy rainfall across India's north eastern highlands and Brahmaputra valley. The other branch spreads heavy and extensive rain across huge regions as it goes toward the northwest through the Ganga River and the Himalayan peaks. Due to the progressively declining humidity of these winds, rainfall in this area diminishes from east to west.

The characteristics of Southwest Monsoons:

(i) These winds generally strike the Indian coast in the first week of June. But their arrival and departure may be before time or even delayed.

(ii) There may be dry spells in between rainy periods. Such long dry spells may even lead to the failure of crops.

(iii) At times, these winds skip over certain regions without any cause.

(iv) The amount and timing of rainfall and the intervening duration of wet and dry spells vary yearly. It is known as the vagaries of the monsoons.

(v) The spatial distribution of rainfall is uneven - some regions may receive heavy rains while others will have to be content with meagre or scanty rains.

(vi) Generally, these winds start retreating by the end of September. But, sometimes, their departure may be delayed till October, or they may retreat much earlier.

The main features of the advancing South west monsoon season are:

- Low-pressure conditions over north western parts of India and high-pressure conditions overseas.
- The general wind direction, particularly on the Arabian Sea and the Bay of Bengal, is southwest to northeast. They cause widespread rain interspersed with dry spells.
- The onset of monsoons is in the first week of June, and withdrawal is by the end of September.
- The weather is generally hot and humid during this season.

iv The Retreating Monsoon Season

The Southwest monsoons start retreating from the Pakistan border in Northwest India in the first week of September. Thus, these winds withdraw earlier from the regions where they reach the last. The retreat of these winds occurs due to the weakening of low-pressure areas over the north western parts. It happens due to low temperatures caused by the apparent shift of the sun towards the equator and also owing to the widespread rains bringing down temperatures perceptibly. Consequently, the air pressure starts decreasing. Such changes in the patterns of atmospheric pressure cause monsoons to withdraw. Hence, this period is known as the season of retreating South West monsoons. By the end of October, these winds retreat from most of northern India. As a result, fair weather conditions prevail over this region.

The low-pressure area lying over Northwest India will be transferred to the middle of the Bay of Bengal by the end of October. As a result of these unstable conditions, severe cyclonic storms originate in the Bay of Bengal. These cyclonic storms strike along the eastern coast of India, causing widespread rain in the coastal regions. Sometimes very severe storms cause damage to standing crops, cattle, property, lines of transport, communication, and even electricity. Tamil Nadu coast receives the maximum rainfall during October and November - the period of retreating monsoons.

The main characteristic features of the retreating monsoon season are:

- Weakening of low-pressure area over Northwest India;
- Fall in temperatures throughout India;
- Shifting of the low-pressure area to the south; and
- Origin of cyclonic storms in the Bay of Bengal, causing heavy rains and damage to crops and property along the eastern coast of India.

INTEXT QUESTIONS 12.3

1. Name the four seasons of India.
2. What is the name of pre-monsoon showers in West Bengal and Assam?
3. Fill in the blanks:

   i. The duration of the cold weather season is from .... to ....

   ii. The low-pressure systems are called "........................

   iii. .... coast receives the maximum rainfall during October and November.

12.4 DISTRIBUTION OF TEMPERATURE AND ANNUAL RAINFALL

Now, let us have a closer look on the distribution of temperature in India. During June, the north western plains experience high temperature around 45°C when areas of Rajasthan desert record day temperatures around 55°C, while the temperatures around Gulmarg or Pahalgam in Kashmir are hardly around 20°C. Similarly, in the month of December, the people of Kargil (in Laddakh) experience biting cold because the night temperatures drop to -40°C, while the inhabitants of Thiruvananthapuram experience temperatures around 27° C.

The range of temperature increases as one moves away from coastal areas to interior parts of the country. As a result, the people living along Konkan and Malabar coasts do not experience extremes of temperatures or marked change in seasons. On the other hand, people living in north western parts of India, experience sharp seasonal contrasts.

Study the map of rainfall distribution carefully. You may find that the regional variations in average annual rainfall are well-pronounced. The rainfall distribution map shows that northeastern parts of Jammu Kashmir and extreme western Rajasthan receive less than 20 cm. On the other hand, the western coastal plains, and Sub-Himalayan areas of northeast India, including the Shillong plateau, receive more than 200 cm. of annual rainfall. Mawsynram gets the most rainfall in India. Mawsynram has a world record of receiving 26,000 millimetres

(1,000 in) of rain in 1985, making it the wettest place on the Earth. It receives 11,872 millimetres (467.4 in) of rain annually on average. Starting from the southern coast of Gujarat, the isohyet of 200 cm. runs somewhat parallel to the coast of Western Ghats up to Kanyakumari. The rainfall drops abruptly below 60 cm to the east of the Western Ghats over interior Maharashtra and Karnataka. Most parts of Punjab, Haryana, central and eastern Rajasthan, and western Gujarat also receive rainfall below 60 cm. Starting from the southwestern parts of Jammu and Kashmir, the isohyet of 100 cm. moves eastwards up to the east of Allahabad, from where it bends to the west and south west, running over western Madhya Pradesh, eastern Maharashtra, and northern Andhra Pradesh, it joins eastern coast near Visakhapatnam. To the west and south west of this isohyet, the areas receive less rainfall. Some parts of the Coromandel coast receive rainfall of more than 100 cm. The areas receiving less than 100 cm. of rainfall depend on means of irrigation for agricultural activities.

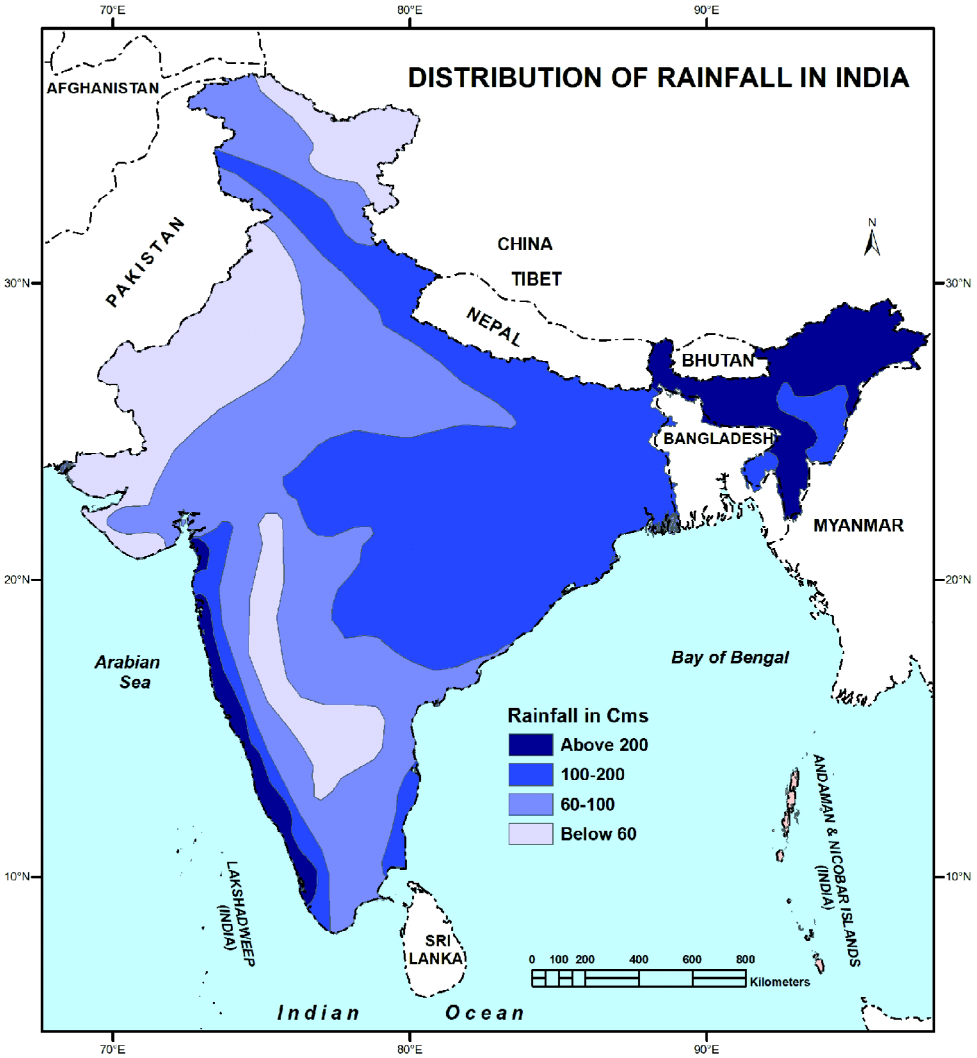


Fig. 12.6 Distribution of Rainfall in India

In India, rainfall distribution, particularly of the south west monsoon, is closely related to the relief. Hence it is even described as "relief" or "orographic" rainfall. By and large, places with higher altitudes have a greater chance of catching more rain than places with less altitude. The

direction of moist winds also matters.

The distribution of annual rainfall in different parts of India shows the following trends:

- The rain decreases as one moves from Kolkata to Amritsar.
- It shows the declining trend towards the interior from the coastal areas on the Deccan Plateau.
- North eastern parts receive more rainfall than north western parts of India.
- Areas lying on the windward side receive more rain than those on the leeward side.

INTEXT QUESTIONS 12.4

1. Fill in the blanks:

   i. …………….. gets most rainfall in India.

   ii. ………………. and extreme western ………… receive less than 20 cm rainfall.

   iii. In India, rainfall distribution, particularly of the south west monsoon, is closely related to the ……………..

WHAT YOU HAVE LEARNT

- India is a country of climatic diversities expressed in the variations in the distribution of temperature, pressure, winds, and amount of precipitation.
- The factors responsible for determining the climate of different regions of India include her location and latitudinal extent, physiography, the role of Himalayan ranges as a climatic divide, the monsoon winds, upper air circulation, western disturbances, and cyclonic storms.
- Derived from the Arabic word 'mousim,' monsoon implies the rhythm of the season and seasonal reversal of winds.
- Meteorologically, the year in India is divided into four seasons, namely the cold weather season, the hot weather season, the advancing southwest monsoon season, and the retreating southwest monsoon season.
- These seasons have different characteristics of weather conditions.

TERMINAL QUESTIONS

1. How do western disturbances influence the weather conditions of north west India?

2. Distinguish between:
   (i) The cold weather season and hot weather season;
   (ii) The southwest and northeast monsoons.
3. Describe five major factors which influence the climate of India. Illustrate your answer with examples.
4. Explain with suitable examples the uneven distribution of rainfall in India.
5. Identify the characteristics of monsoons in India.

ANSWERS TO INTEXT QUESTIONS

12.1

1. Location and Latitudinal Extent, Distance from the Sea, The Northern Mountain Ranges, Physiography, Monsoon Winds etc (Any three)
2. El Nino
3. Fill in the blanks:
4. Mousim
5. Bay of Bengal
6. Himalayas

12.2

Fill in the blanks:

1. Flohn
2. Wheat.
3. Cotton, Woolen

12.3

4. Four seasons in India:
   i. The cold weather season - December to February;
   ii. The hot weather season - March to May in the south and up to June in the north;
   iii. The advancing southwest monsoon season - June to September;
   iv. The retreating southwest monsoon season - October and November.
5. Kal Baisakhi
6. Fill in the blanks:
   iv. December, February
   v. Western disturbances
   vi. Tamil Nadu

12.4

2. Fill in the blanks:
   iv. Mawsynram
   v. Jammu Kashmir, western Rajasthan
   vi. Relief

13

NATURAL HAZARDS AND DISASTER

In the previous lesson you have learnt the role of climate. Many natural disasters are of climatic origin. In this lesson we would try to learn how natural extreme events of different origins like climate, hydrology, geology etc impacts humans and their structures resulting in disasters. The disasters have negative impacts on human beings and the environment. The negative impacts can be short or long lasting. The natural disasters cause death, injury, destruction of infrastructures, transport systems etc. It leads to financial losses of development and overall backwardness of the area.

Therefore, adaptation of suitable disaster mitigation and management strategies need to be taken up seriously. Among the top ten natural disaster-prone countries, India stands second after China. In this lesson, we will focus on some important disasters.

OUTCOMES

After studying this lesson, learner:

- differentiates between 'Hazard' and 'Disaster';
- explains various types of disasters;
- identifies disaster prone areas in India;
- suggests disaster management measures to reduce impacts of disasters and
- explains national and international measures adopted for Disaster Risk Reduction

13.1 HAZARD AND DISASTERS

Hazard is a danger defined as a phenomenon or natural condition having the potential of causing loss of lives, injury and destruction of properties. Overall it has the possibility of economic disruptions and environmental damage.

Notes

Hazard is called a disaster only when it really affects a certain population. The occurrence of natural disasters cannot be controlled by human beings but with better mitigation and management measures their impacts may be minimised.

Due to human intervention in the natural processes, the destructive magnitude and frequency of natural disasters have increased considerably in recent times. The severity of disasters depends on our preparedness. The scale of the impact in turn depends on the choices we do have. The choices are concerned with our capabilities to cope with the disaster. For example a well built house has a higher possibility of coping with the wrath of nature than ill-built houses. It is called vulnerability. Well built houses are less vulnerable while the ill-built houses are highly vulnerable to disasters.

Hence, disaster is defined as: "… a serious disruption of the functioning of a society, causing widespread human, material, or environmental losses which exceed the ability of the affected society to cope using its own resources." The United Nations defines disaster as "…the occurrence of a sudden or major misfortune which disrupts the basic fabric and normal functioning of a society or community."

It is an event or a series of events which gives rise to casualties and/or loss of property, infrastructure, essential services or means of livelihood on a scale that is beyond the normal capacity of the affected communities to cope with. Disaster is sometimes also used to describe a "catastrophic situation in which the normal patterns of life or ecosystems have been disrupted and extraordinary emergency interventions are required to save and preserve human lives and / or the environment".

a) According to an estimate, about 60,000 people per year are killed by natural disasters and are responsible for 0.1% of global deaths in last 100 years.

b) According to UN statistics, natural disasters cause property damage of around Rs 20,000 crores worldwide every year.

A disaster occurs when hazard impacts vulnerable people or communities of a certain area. It happens when their inability to reduce the potential negative consequences surpasses their capacity to cope.

(Natural Hazard + Vulnerability Risk)/ Capacity = DISASTER

The Characteristic of hazard and disaster are summarised in Table 13.1.

Table 13.3 Differences between Natural Hazard and Disaster

	Natural Hazard		Disaster
1.	Hazards are dangerous physical conditions or events.	1.	Most of the disasters occur rapidly, instantaneously and indiscriminately.
2.	Hazards have potential of damaging different forms of lives	2.	Disasters are largely viewed from a human perspective causing severe damage to human life and property.
3.	Hazard represents a latent threat to damage biotic and abiotic components of the environment.	3.	Disaster disrupts the normal functioning of society and the physical environment.
4.	Hazards may or may not turn into disasters.	4.	All disasters cause damage to property and loss of lives. A large number of people are affected.
5.	External aid is not required to damage biotic and abiotic components of the environment.	5.	It affects the society and socio, economic and physical environment to such an extent that external aid becomes necessary.
6.	Earthquakes, floods, cyclones, volcanic eruptions, landslides, droughts etc are called natural hazards before they cause loss of life and damage to property.	6.	Earthquakes, floods, cyclones, volcanic eruptions, landslides, droughts etc are called natural disasters after they cause loss of life and damage to property.
7.	People are not affected.	7.	People are affected
8.	Hazards also occur in areas not occupied by human beings.	8.	Hazards turn into disasters when they occur in the inhabited areas with infrastructures, buildings, telecommunications etc.
9.	Hazards are processes of the genesis of extreme events	9.	Disasters are the responses to the aftermath of natural hazards.

13.2 TYPES OF NATURAL DISASTERS

Natural disasters are those which are caused by nature and are beyond human control. But it is also true that rampant human activities accelerate the impact of natural disasters. For example a judicious use of mountain slope, over irrigation. Deforestation, road construction on slopes intensifies the impact of natural disaster landslides. There are several types of natural disasters like floods, cyclones, earthquakes and volcanic eruptions etc. the types of natural disaster are very clearly shown in figure.

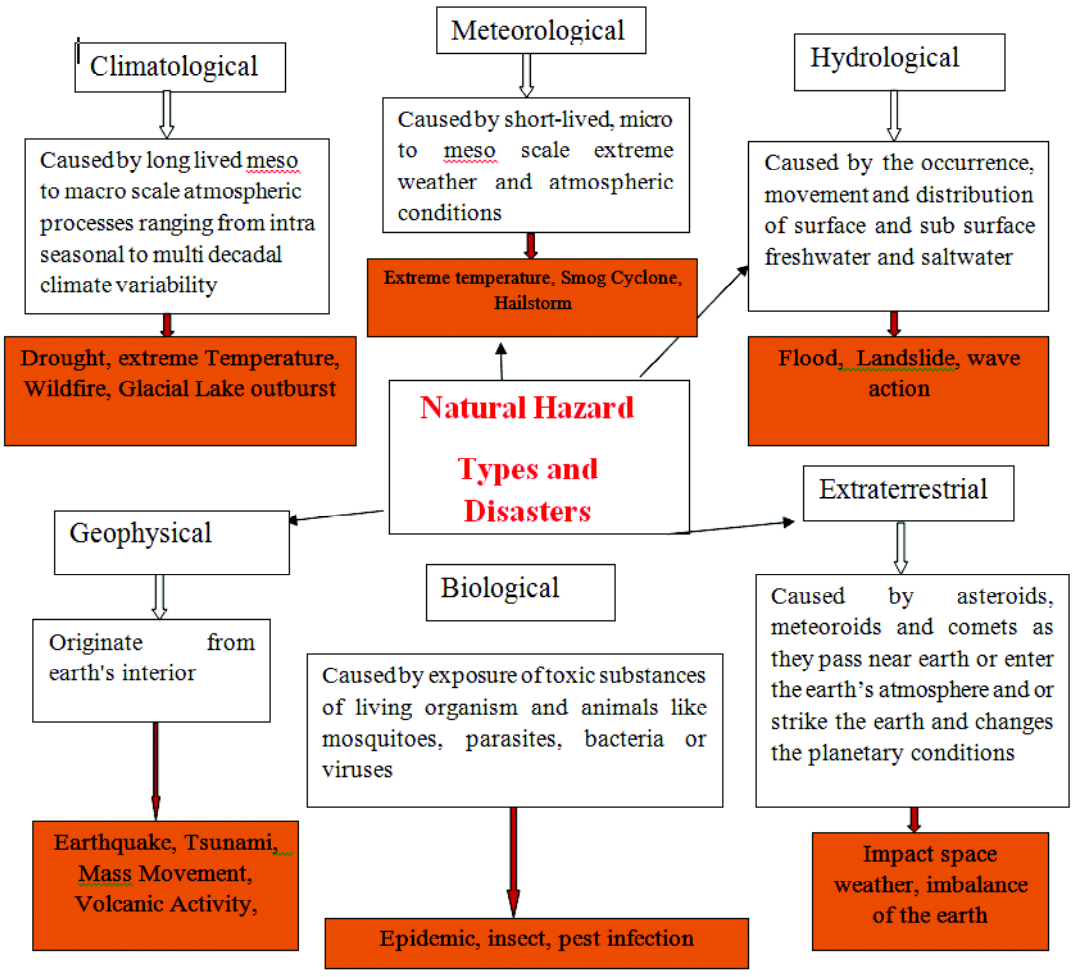


Fig. 13.1 Types of Natural Disaster

INTEXT QUESTIONS 13.1

1. Deaths and destruction for infrastructures happen in -

   (i)………………………….. (ii)……………………

2. Disaster equation

(…………………+…………………+……………..…)……………= Disaster

3. Match the following

Type of natural disaster	Source of natural disaster
a) Meteorological	i. Surface and subsurface water - fresh and saltwater
b) Hydrological	ii. Outer space material fall of meteoroids and asteroids on earth
c) Extra-terrestrial	iii. Living organisms
d) Biological	iv. Short lived micro and meso atmospheric conditions
e) Geophysical	v. Long lived meso and macro atmospheric processes
f) Climatological	vi. Originate from earth's interior

4. True or false

   a) All disasters cause damage to property and loss of life

   b) People are affected by hazards

   c) Hazards always become a disaster

   d) People enjoy during disaster

A. Floods

Flood is the rise of water levels which are abnormally high and inundated neighbouring areas. This could be because of heavy precipitation in the river basin, dam failure, rapid snow melts, cloud bursts, glacial lake outbursts, storm surges etc.

Floods are of three types

a) River Floods

b) Flash Floods

c) Coastal Floods

Notes

Causes of flood

The causes of flood are:

(i) Heavy rainfall: Heavy rain in the catchment area of a river causes water rush downstream resulting in flooding in nearby areas.

(ii) Sediment deposition: Siltation in river course causes reduction in capacity to carry water. As a result, the heavy rain waters over flows the river banks.

(iii) Deforestation: Vegetation hampers the quick flow of water and forces it to percolate in the ground. Barren land surface is subject to soil erosion. Obstruction-free surroundings in the catchment area of a channel cause flooding during the rainy season.

(iv) Cyclones: It generates sea waves of abnormal height (storm surges) and causes spreads of water in the adjoining coastal areas.

(v) Interference in drainage system: Drainage congestion caused by badly planned construction of bridges, roads, railway tracks, canals etc. hampers the flow of water and the result is flooding.

(vi) Natural Change in the course of the river: As river changes, it course in inundated new areas

(vii) Tsunami: Large coastal areas are flooded by rising sea water because of underwater earthquakes.

(viii) Dam Failure: due to earthquake or human induced factors dams are damaged and broken causing flooding downstream.

B. DROUGHT

Drought has economic, environmental and social impacts. In India, around 68% of the country is prone to drought in varying degrees. Area receiving rainfall between 75 cm to 112.5cm is considered drought prone constituting 35% of total area. With rainfall less than 75 cm is chronically drought prone and it covers 33% of the total area of the country.

According to meteorologists the rainfall deficiency during a long period over a large area is called a drought. IMD defines Drought as a situation occurring in any area when mean annual rainfall is less than 75% of the normal rainfall. Some times in Hindi language famine Akal and Anavrishty are also used for drought. Drought can also occur when ground water level is not within reach of agricultural communities. The government also declares drought, if more than 50 percent crop loss happens in an area due to meteorological conditions.

Causes of Drought

Major cause of drought is scarcity of rain. But humans have interfered in the natural processes by their activities. People have filled up the natural resources like ponds and lakes. They have removed the vegetation cover. Vegetation cover impedes the flow of rainwater and forces it to percolate. Over utilisation of ground water resources through tube wells is drying ground aquifers. Inadequate rainfall changes in local landscape, meteorological, hydrological, agricultural factors cause drought.

Impact of Drought

Droughts cause scarcity of food and water. People die of hunger, malnutrition and epidemics. Crops fail due to scarcity of water. Cattle are either small nourished or die due to shortage of fodder and water. Farmers are deprived of their employment. People are forced to migrate out of their villages in search of livelihood.

C. CYCLONES

Cyclones are the centre of low atmospheric pressure. The air pressure increases from the centre to the outer areas. Consequently winds blow from outside to the centre. In cyclones, winds blow in an anticlockwise direction in the northern hemisphere and clockwise in the southern hemisphere. On the basis of their location and physical properties cyclones are of two types; temperate cyclones and tropical cyclones.

Cyclone is a violent circular storm, winds. It is associated with torrential rain, high speed winds and sea surges (water raises). Cyclones play an important role in the general circulation of the atmosphere.

Occurrence and movement of Cyclones

Cyclones have seasonal cyclic patterns. It originates over the sea surface and dissipates as they reach land. In India, most of the cyclone occurrence is concentrated in the post monsoon season, i.e. from October to December or in the pre-monsoon season from April to May. The lifespan of a cyclone can range between 7 to 14 days from its development to landfall. The cyclone moves forward from east to west in Bay of Bengal with an initial.

Speed of 15 to 30 km per hour. Later on the speed reaches to over 90 KM/hour and in extra cases it goes beyond 250 KM/hour. High sea waves are generated in the sea by speedy cyclonic winds. They strike the coastal areas like high walls of water and flood the areas upto 10-15 km from the coast. The impact can be felt upto 50 kms inland. The cyclone that struck Odisha originated near Andaman & Nicobar Islands and reached Orissa on 29-10-1999 after many days. The movement of a cyclone in a direction is like the movement of a spinning top.

Impacts of cyclones and floods

(i) Damage to build up structures: The violent winds of a cyclone destroy whatever comes in their way from; thatched huts to the palaces, houses, forts, lines of electricity and communication.

(ii) Natural Habitat: High speed winds cause damage to vegetation. Trees are uprooted. Salt water intrudes in coastal areas leaving the soil infertile.

(iii) Floods: Torrential rain causes floods. Floods wreak havoc all around.

D. Landslides

The youngest and the highest Himalayan fold mountain chain is the crown of our country. The Indian Plate is moving in a northward direction causing stress on the rocks making them weak and prone to landslides. Landslides take place in the form of earth flows, debris flows and rock falls.

The slipping of masses of rocks, earth or debris downwards on the mountain slopes or banks of the rivers is called a landslide. Landslides occur when shear stress along the slope exceeds frictional force. It results in a landslide and gravitational force brightens the rock material down the slope. The occurrence of landslides in mountainous areas is increasing day by day.

Landslides are intensified by rain, earthquakes, volcanic eruption, deforestation and slope failure.

Causes of Landslides

i. Heavy rain: Heavy rain is the main cause of landslides.

ii. Deforestation: Deforestation is another major cause of landslides. Mountain slopes lose their protective cover by felling of trees. The rain water flows on such slopes with unimpeded speed causing landslides of barren slope fronts.

iii. Earthquakes and Volcanic Eruption: Tremors destabilise the mountains and the rocks tumble downwards. Volcanic eruptions also trigger landslides in the mountainous areas.

iv. Building of roads: During the process of the construction of roads, a large amount of rocks and debris has to be removed by blasting. This process dislodges the rock structure and changes the angle of slopes. Consequently landslides are triggered.

v. Shifting Agriculture and Irrigation Networks: In the North Eastern part of India, the number and frequency of landslides has increased due to the practice of shifting agriculture.

vi. Tourism, infrastructure, construction and increasing settlement sizes in fragile mountain ecosystems increases instances of landslides.

Notes

Impact of landslides

(i) Landslides are degrading the environment and natural beauty of mountains.

(ii) Sources of water are drying up.

(iii) Flooding in rivers is increasing due to debris flow from deposits brought by landslides.

(iv) Roads get blocked; power and communication lines get disrupted.

(v) Life and structural property loss.

E. EARTHQUAKE

Earthquakes can occur at any time. Its impact is very sudden. There are no warning signs of earthquakes. Earthquake is sudden shaking or trembling of the earth surface caused by passage of seismic waves. Most earthquakes are minor tremors. Larger earthquakes usually begin with slight tremors but suddenly they turn into violent shocks and after that they diminish. Tremors or shocks are felt for a few seconds only.

In spite of extensive research, it is not possible to forecast or predict earthquakes. INSAR (Interferometry Synthetic Aperture Radars) are used in certain earthquake prone areas but they can only predict just a few seconds before an earthquake strikes.

Impact of Earthquakes

(i) **Damage of Property:** When an earthquake occurs, buildings from cottages to palaces and skyscrapers are subject to damage. Underground pipelines and railway lines are damaged or broken. Dams on river collapse, resultant floods cause havoc. The earthquake in 1967 in Koyna damaged the Dam.

(ii) **Human Loss -** Normally the duration of earthquake tremors is only a few seconds, but thousands of people may die in this short period. The Bihar earthquake of 1934 killed 10,000 people and the Kangra earthquake of 1905 caused 20,000 people dead. Numerous people lost their shelter and many became orphans. The earthquake that occurred in Gujarat on 26 January 2001 was devastating. More than 25,000 people died due to the impact of this earthquake. The destruction of property was tremendous.

(iii) **Changes in River Courses:** Sometimes river channels are blocked or their courses are changed due to the impact of an earthquake.

(iv) **Tsunamis:** are caused by underwater earthquakes which trigger very high sea waves over the coastal areas. It wreaks havoc on settlements of coastal areas. It sinks large ships. Tsunami that occurred on 26-12-2004 near the coast of Sumatra (Indonesia)

Notes

damaged property worth billions of rupees. More than two lakh people lost their lives in Southeast Asia, India and Sri Lanka.

(v) **Fountains of Mud:** Due to the intense impact of the earthquake, water and mud appear on the surface and take the form of fountains. It leads to spreading sand on agricultural land and making it infertile.

(vi) **Cracks and Fissures:** Sometimes cracks and fissures develop in roads, railway tracks, and fields.

(vii) Landslides and avalanches are triggered by earthquakes

INTEXT QUESTIONS 13.2

1. Name the types of floods.

   (i) ……………………. (ii) …………………..(iii)……………..

2. Fill in the blanks

   a) Flood caused due to dam failure is because of ....or ………………

   b) The movement of wind in cyclones is …………….. in Northern Hemisphere and ………………in Southern hemisphere

   c) Droughts are called ………………and ……………..in Hindi.

   d) Droughts cause scarcity of …… and………

3. Define landslide.

4. What is caused by underwater earthquakes?

5 True and False

   a) Calm centre of a cyclone is called "eye" of the storm

   b) Heavy rainfall is one of major cause of flooding

   c) It is easy to predict earthquakes

   d) Chronic drought prone areas receive less than 75 cms of rainfall

   e) Shifting agriculture reduces landslides

13.3 DISASTER RISK

Risk is the potential disaster which causes losses of lives, properties and infrastructures. It is dependent upon the situation of danger (hazard). Physical, socioeconomic and environmental coping capacity (vulnerability) and the quality of structures the community has exposure to. Hence a common overlapping of these three is called risk.

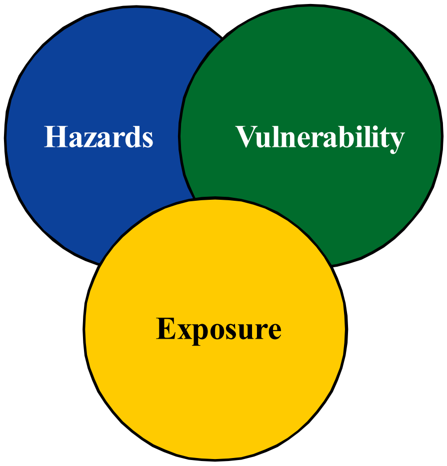


Fig. 13.2 Identification of Risk

A single disaster has a different impact on different people in the society. Poor people have less capacity to cope with the disaster in comparison to rich people. Because poor people have less strong houses constructed in low economic zones, situated in low lying areas with less economic power. All are making them more vulnerable to any disaster. They are more exposed to nature and subject to risk. On the other hand, the reverse is the case with rich people. Therefore risk is determined by hazard, vulnerability and exposure of the people to the disaster.

13.4 NATURAL DISASTERS PRONE AREA IN INDIA

India has a unique geo- climate, physiographic and socio- economic conditions. The country is vulnerable to droughts, floods, cyclones, landslides, earthquakes, avalanches, forest fires etc. Out of 28 states and 8 Union territories 27 of them are disaster prone. Almost 68% of cultivable area is prone to droughts; 58.6% of land is prone to earthquakes of moderate to severe intensity; 12% vulnerable to floods 76% of the total coastal length is prone to cyclones and tsunamis; around 8% of greater Himalayas and middle Himalayas is vulnerable to avalanches during winter months around 15% forest areas experience forest fires during dry season.

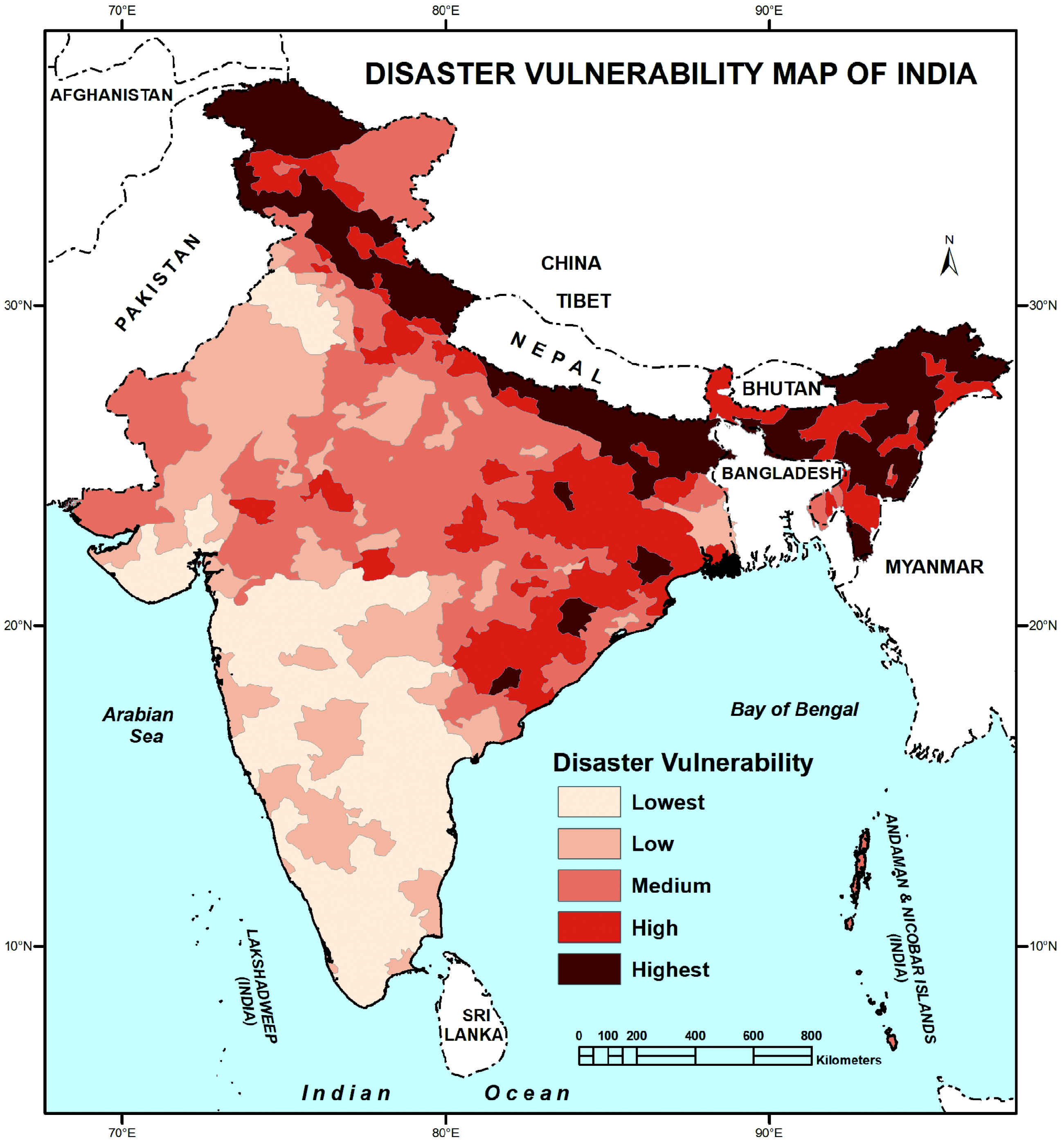


Fig 13.3 Disaster Vulnerability Map of India

India is one of the ten most disaster prone countries of the world. The country is prone to disasters due to a number of factors; both natural and human induced. The Himalayan region is prone to disasters like earthquakes and landslides The geo-tectonic features of the Himalayan region and adjacent alluvial plains make the region susceptible to earthquakes, landslides, water erosion, etc.

The plain is affected by floods almost every year. Major rivers bring a huge quantity of sediment

load and choke the river bed. Water carrying capacity is reduced and flooding becomes a regular feature. The desert part of the country is affected by droughts. The western part of Rajasthan, Gujarat and some parts of Maharashtra are hit very frequently by drought. The coastal zone is susceptible to cyclones. The Geo-tectonic movements going on in the ocean floor make the coastal region prone to tsunami disaster too.

A. Drought prone areas of India

Study the map carefully given below (Fig 6). There is a Major region between South Rajasthan and Tamil Nadu that is drought prone. It includes west Rajasthan, Gujarat, West Madhya Pradesh, central Maharashtra, Karnataka and Tamil Nadu. Due to deficiency in monsoon rainfall and environmental degradation, Rajasthan and Gujarat are generally affected by drought. Out of 640 districts (2011 census) 283 districts are in the rain-deficient category. They are drought prone districts according to the India Meteorological Department.

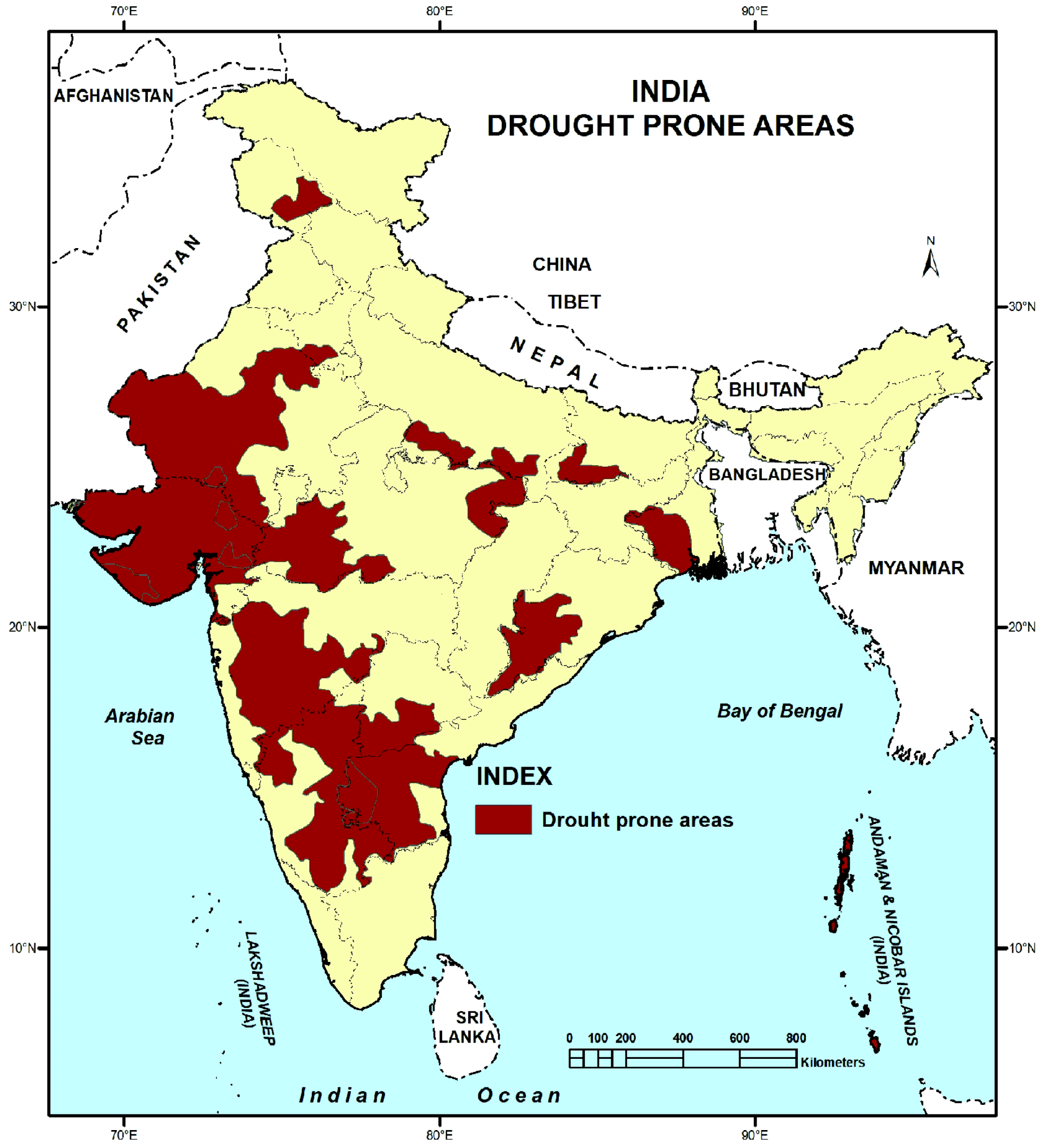


Fig 13.4 Drought Prone Areas

B. Flood Prone Areas

At present, about 12% of the country is assessed to be flood prone. Out of total damage by floods to crops and property about 75% occurs in northern plains and eastern India drained by Ganga, Brahmaputra and their tributaries. Uttar Pradesh, Bihar and Assam are chronically flood prone followed by Haryana, Punjab and Andhra Pradesh. Recently Rajasthan and Gujarat also feel the fury of floods. Karnataka and Maharashtra are no-longer immune to floods. Most recently added to the list are former Jammu & Kashmir (Kashmir floods of 2014) and Tamil Nadu (Chennai floods of 2015).

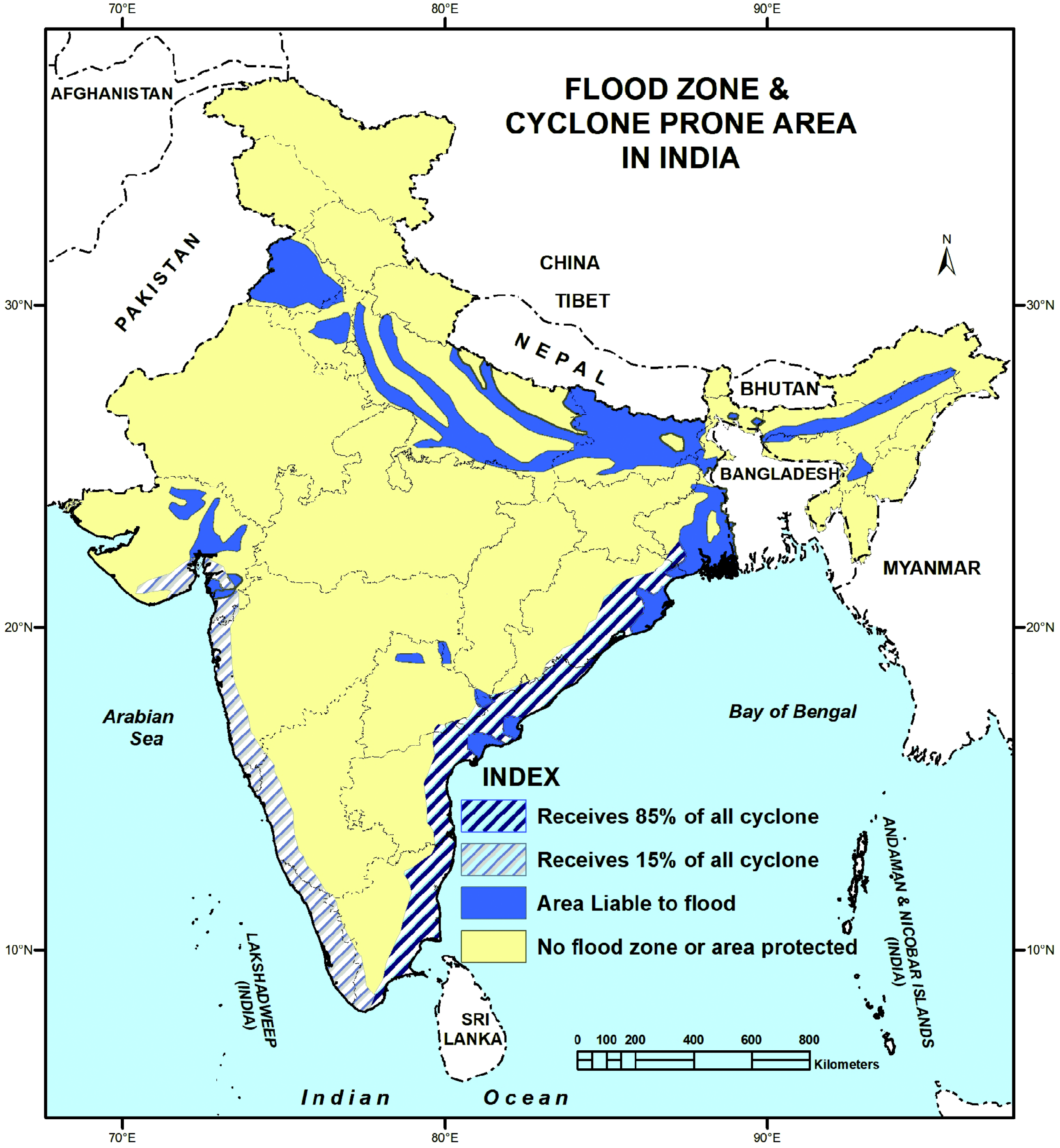


Fig. 13.5 Flood and Cyclone Prone Area

C. Cyclone Prone Areas

The eastern coast of India is the most cyclone affected region. On an average out of 100 cyclones 85 strike the east coast of India whereas the west coast receives only 15. The cyclone prone states are West Bengal, Odisha, Andhra Pradesh and Tamil Nadu. Western coast is affected by the cyclones which originate in the Arabian Sea. Gujarat is most affected on the west coast.

D. Landslide Prone Areas

Landslides come under hydro-geological hazards. The Himalayas, Northeastern Hills and Western Ghats, experience landslides especially in monsoon month. The landslides are a common feature in Western Ghats and Konkan hills (Kerala, Tamil Nadu, Karnataka, Goa and Maharashtra). The North West Himalayas (Jammu & Kashmir, Himachal Pradesh, Uttarakhand) and North East Himalayas Sikkim West Bengal Mizoram, Tripura, Meghalaya, Assam, Nagaland and Arunachal Pradesh experience chronic landslide problems. They are most vulnerable and bear the brunt of landslides. They are the cause of recurring economic and human losses.

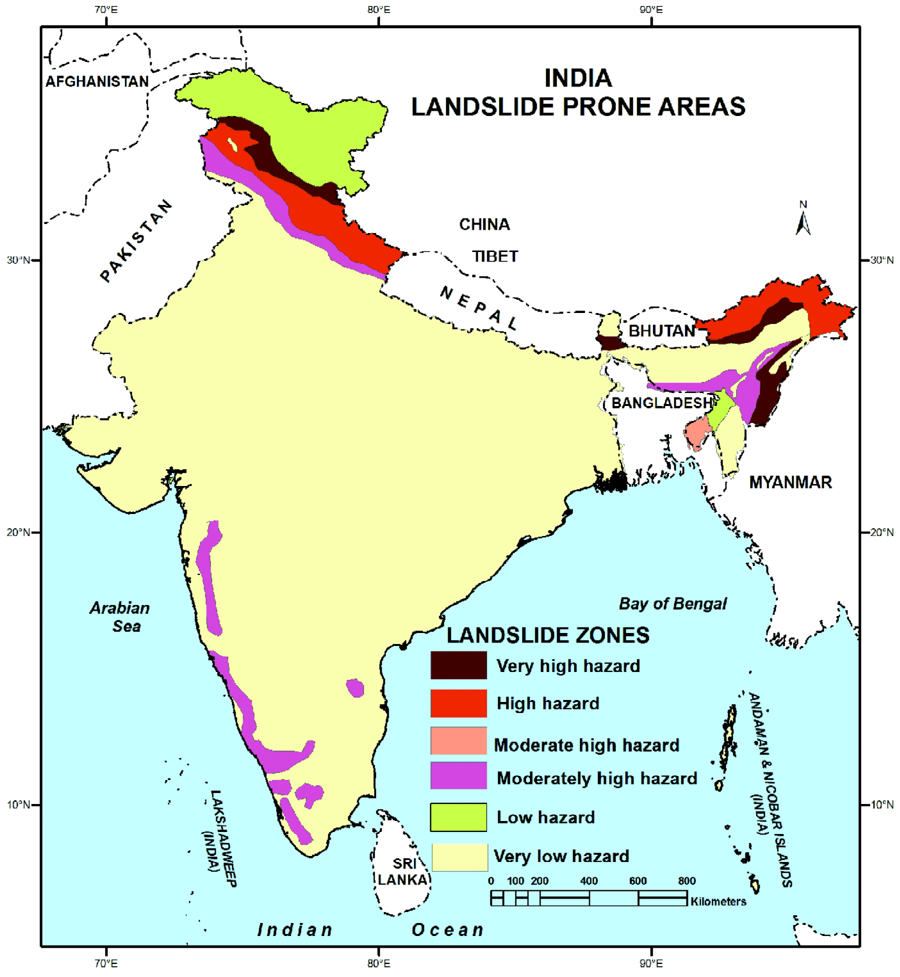


Fig. 13.6 Landslide Prone Area

Notes

E. Earthquake Prone Areas

Earthquakes are generated due to internal processes of the earth. Primarily, it is caused by earth movements. Depending upon the internal activities, its distribution is clearly marked by spatial patterns. Server earthquakes are associated with plate tectonics and plate boundaries. With increasing distance, its intercity keeps on reducing. Based on the intensity of the earthquakes, India is divided into four seismic Zones. They are;

- Zone - V Highest risk of damage - The area includes northeastern India, parts of Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Rann of Kutch in Gujarat, part of North Bihar and Andaman & Nicobar Islands).
- Zone - IV High damage risk - the area includes some parts of Jammu and Kashmir and Himachal Pradesh, National Capital Territory (NCT) of Delhi, Sikkim, northern parts of Uttar Pradesh, Bihar and West Bengal, parts of Gujarat and Maharashtra.
- Zone -III Moderate damage risk - The area includes Kerala, Goa, Lakshadweep islands, southern parts of Uttar Pradesh, Gujarat and West Bengal, parts of Punjab, Rajasthan, Madhya Pradesh, Bihar, Jharkhand, Chhattisgarh, Maharashtra, Orissa, Andhra Pradesh, Tamil Nadu and Karnataka.
- Zone - II Low damage risk - the area includes remaining parts of the country.

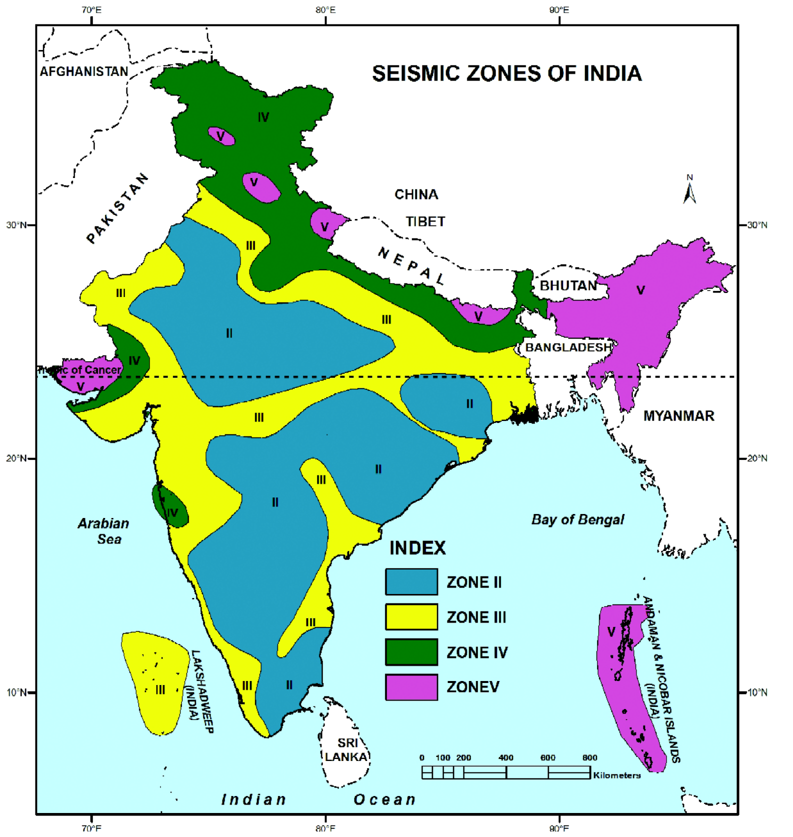


Fig. 13. 7 Earthquake Prone Areas

INTEXT QUESTIONS 13.3

1. Match the following

	Disaster		**Area affected in percent**
1	Drought prone	A	58.6 % land area
2	Earthquake prone	B	8% land area
3	Floods prone	C	68 % land area
4	Avalanche prone	D	15% land area
5	Forest fire prone	E	12% land area

2. East coast of India witness .... of total cyclones along Indian coast.

3. At present .... of the total land area of the country is assessed to be flood prone.

4. Out of 640 districts (2011 census) ....districts in the country currently fall in the rain-deficient category.

13.5 CONCEPTS OF DISASTER MANAGEMENT

Disaster management includes various activities for avoiding or reducing ill effects of disaster. It also helps in providing better recovery, bringing normally after disaster as well as preparing for disaster too. All government, non-governmental and community-based organisations play vital roles in the process. It now includes pre-disaster planning and preparedness activities, organisational planning, training, information management and public relations. Disaster management includes precaution, mitigation, preparedness, response, recovery and reconstruction.

Pre-disaster	**During -disaster**	**Post-disaster**
Preparedness	Response	Response
Prevention	Relief	Recovery
Mitigation		Reconstruction

1. **Disaster Preparedness :** It is a set of measures adopted well in advance for response and to cope with disaster in a better way. Its prime concern is to reduce the loss of human life and property.

2. **Disaster Prevention :** Avoidance of ill impact of disaster is termed as prevention of disaster. It is quite obvious that complete avoidance of any disaster is not possible but it could be minimised. Its compounding effects could be avoided/prevented by building the capacity of individual/society or community.

3. **Disaster Mitigation :** It is the reduction of harmful effects of disasters. It refers to ongoing efforts at different levels starting from individual, local community, to state and national. It includes hazard and disaster mapping and zonation building specific plans for disasters in certain areas prone to it execution of the plan in needed hours is very important for mitigation.

4. **Disaster Relief :** It is immediate help and support made available to affected people. It is of great importance to minimise suffering and extend basic minimum needs to support life. It includes providing food, water, shelter and medical care.

5. **Disaster Response :** It refers to the action taken up immediately after the disaster happened. This includes many efforts like rescue, establishment of marginal health care, treating injured supplying eatables, shifting people to safe places etc. the first and immediate response is generally provided by local youths, volunteers and later on, the action of district, state or local level help arrives.

6. **Recovery after Disaster:** It refers to providing help to affected people in a shortest possible time. It depends upon the ability of the organisation/efforts taken by the NGOs district state or national level disaster management authority

7. **Disaster Reconstruction :** it refers to the construction of a situation again after its destabilisation/imbalance due to disaster. It involves partial or complete relocation and reestablishment of essential infrastructures and shelter. It helps in reducing the trauma to some extent, especially related to physical facilities needed for infected people.

INTEXT QUESTIONS 13.4

1. Name any five disaster management activities.
2. What are three stages of Disasters.

13.6 MANAGEMENT AND MITIGATION OF MAJOR NATURAL DISASTERS IN INDIA

Disaster **Mitigation and Management of Disasters**

Floods (i) **Reservoirs:** By constructing reservoirs in the course of rivers could store extra water at the time of flood.

(ii) Embankments: By building flood protection embankments, flood water can be controlled from overflowing the banks and spreading in nearby areas.

(iii) Afforestation: The fury of flood could be minimised by planting trees in catchment areas of rivers.

Some important precautions:

- Avoid building houses in flood prone areas unless you elevate and reinforce your home.
- Elevate the furnace, water heater, and electric panel if susceptible to flooding.
- Install "Check Valves" in the sewer to prevent backing floodwater.
- Contact community or government officials to find out if they are planning to construct levees or floodwalls.
- Seal the walls in your basement with waterproofing.
- Listen to the radio or television for information.
- Be aware of flash flooding. If there is any possibility of flood, move immediately to higher ground.
- Be aware of streams, drainage channels and other areas known to flood suddenly.
- Secure your home. If you have time, shift outdoor furniture and essential items to the upper floor.
- Disconnect electrical appliances. Do not touch electrical equipment if you are wet or standing in water.
- Do not walk through running water.
- Do not drive into flooded areas. If floodwaters rise around your car, abandon the car and move to higher ground.

Droughts (i) Suitable farming methods for arid areas: Production of coarse and hardy cereals; conservation of soil moisture by deep ploughing, storing water behind small dams, collecting water in ponds and tanks and use of sprinklers for irrigation.

(ii) Sowing drought resistant crops: By sowing drought resistant crops like cotton, moong, pearl millet, wheat etc, the impact of drought could be minimised to a certain extent.

Notes

(iii) **Rain water harvesting:** Collection of each and every drop of rain could help in coping with the drought.

(iv) Making high bunds around the fields, planting trees on the bunds of fields, the use of rainwater can be maximised.

(v) Irrigation canal construction with mortar and bricks

(vi) Small quantity of water can irrigate a comparatively larger area by using a drip irrigation method.

Landslide

- Database of vulnerable sites and location
- Awareness and development of both indigenous and modern methods
- Detailed landslide hazard zonation mapping
- Afforestation : Trees and brushes help in binding the soil particles.
- Ban on quarrying of stones and mining of minerals in fragile areas
- Permanent crops like orchards of fruits should replace the seasonal or annual crops.
- Retaining walls can be built on mountain slopes.
- Ban construction activities in landslide prone areas/spots.

Earthquake

- Analysis of seismic risk and its zonation;
- Design and construction of earthquake resistant structures.
- Retrofitting of existing structures strengthening them.
- Earthquake insurance for houses to reduce the economic impact on individuals.
- Installation of seismological observations for monitoring seismic activity.

Cyclones

- Check the house; secure loose tiles and carry out repairs of doors and windows
- Remove dead branches or dying trees close to houses;
- Fixing of removable objects such as lumber piles, loose tin sheets, loose bricks, garbage cans, sign-boards etc.

- Keep some wooden boards ready so that glass windows can be boarded if needed
- Keep a cyclone lantern filled with kerosene, battery operated torches and enough dry cells
- Demolish condemned buildings
- Keep some extra batteries for transistors
- Keep some dry non-perishable food always ready for use in emergency
- Listen to the radio for weather warnings.
- Keep monitoring the warnings. This will help you prepare for a cyclone emergency.
- Pass the information to others.
- Believe in the official information
- When a cyclone alert is on for your area, stay alert to the warnings.

INTEXT QUESTION 13.5

1. Write major plans and programmes adopted by government of India to control floods
2. Landslide Hazard Zonation -micro zonation on ………………….. scale
3. Give three main measures adopted to control floods.

13.7 NATIONAL AND INTERNATIONAL INITIATIVES FOR DISASTER RISK REDUCTION

In 2005 the Indian government took its first major initiatives known as Disaster Management Act-2005. Later on, it is National Disaster Management Policy-2009 and National Disaster Management Plan-2016.

New Directions for Disaster Management in India

- A National Disaster Mitigation Fund will be administered by the National Disaster Management Authority (NDMA). States and districts will administer mitigation funds.
- A National Disaster Response Fund will be administered by NDMA through the National Executive Committee. States and Districts will administer state Disaster Response Fund and Disaster Response Fund respectively.

Notes

- 8 Battalions of the National Disaster Response Force (NDRF) are being trained and deployed with CSSR and MFR equipment and tools in eight strategic locations. National Institute of Disaster Management (NIDM) is a national level training institute which trains professional, educationalist, government organisations, school and college students.
- A National Disaster Management Policy and National Disaster Response Plan will also be drawn up.
- Strengthening of State Disaster Management Authorities (SDMAs) and District Disaster Management Authorities (DDMAs)

Future Directions

- Encourage and consolidate knowledge networks.
- Aapda Mitra Scheme
- Mobilise and train disaster volunteers for more effective preparedness, mitigation and response (NSS, NCC Scouts and Guides, Civil Defense, Home Guards).
- Increased capacity building leads to faster vulnerability reduction.
- Learn from best practices in disaster preparedness, mitigation and disaster response.

The Sendai Framework for disaster risk reduction (2015-30) was adopted at the 3rd United Nations World Conference on Disaster Risk Reduction (WCDRR) on 18th March, 2015 at Sendai, Japan. It was the successor to Hyogo Framework for Action (HFA) 2005-15- Building the Resilience of Nations and Communities to Disasters.

The framework outlines four priorities for action to prevent new and reduce the existing disaster risk.

(i) Priority 1: Understanding disaster risk

(ii) Priority 2: Strengthening disaster risk governance to manage disaster risk

(iii) Priority 3: Investing in disaster risk reduction for resilience

(iv) Priority 4 : Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction

The framework recognizes the primary role to reduce disaster risk is with the state but the responsibility should be shared with other stakeholders including private sector and local government with other stakeholders. It focuses on taking measures addressing three dimensions of disaster risk to prevent. They are (a) creation of new risks and vulnerabilities, (b) reduction of the existing risks and (c) enhancing resilience.

The Sendai Framework monitors 38 indicators towards Seven global targets through online tools that collect self-reports by member countries. Seven global targets for guidance to assess progress are.

- Substantially reduce global disaster mortality by 2030, aiming to lower average per 100,000 global mortality between 2020-2030 compared to 2005-2015.
- Substantially reduce the number of affected people globally by 2030, aiming to lower the average global figure per 100,000 between 2020-2030 compared to 2005-2015.
- Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030.
- Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030.
- Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020.
- Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of this framework by 2030.
- Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030.

The purpose is to provide multi-hazard management of disaster risk in development at all levels across all sectors and within. The aim is to achieve substantial reduction of disaster risk.

To prevent new and reduce existing disaster risk by implementation of integrated and inclusive structural, economic, social, health, legal, cultural, educational, environmental, political, technological and institutional measures. They prevent and reduce hazard exposure and vulnerability to disaster, increase recovery and preparedness for response towards disasters. In this way strengthening in resilience is aimed at.

INTEXT QUESTIONS 13.6

1. Write the full form of the abbreviations-

   a) NDMA-

   b) NDRF-

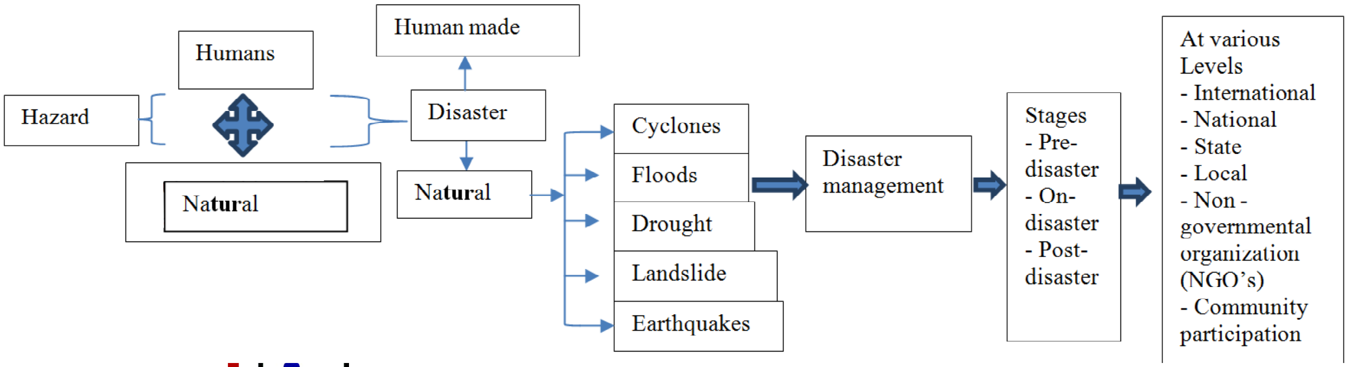
c) SDMA's-

d) DDMA's-

e) WCDRR-

f) NIDM-

WHAT YOU HAVE LEARNT



TERMINAL QUESTIONS

1. Differentiate between Hazard and disaster

2. Identify various types of Disaster and their causes with help of flow chart

3. Briefly explain the initiatives taken by the Indian government in the field of Disaster management.

4. What are practices involved in managing following disasters? Explain in detail.

   - Flood
   - Earthquake
   - Cyclone
   - Landslides
   - Droughts

5. Identify Flood Disaster-prone areas in India, also distribution on map of India.

6. Identify Drought Disaster-prone areas in India.

7. Identify Earthquake Disaster-prone areas in India.

8. Identify Cyclone Disaster-prone areas in India.

9. Identify Landslide Disaster-prone areas in India.

10. On the map of India show Levels of Disaster vulnerability.

11. Explain in detail three stages of Disaster Management.

12. Elaborate on Sendai Framework on Disaster Risk Reduction.

ANSWERS TO INTEXT QUESTIONS

13.1

1. (i) natural (ii) human-made

2. Natural Hazard Vulnerability Risk)/ Capacity= DISASTER

3.

	Type	**Source**
a)	Meteorological	Short lived micro and meso atmospheric conditions
b)	Hydrological	Surface and subsurface water - fresh and saltwater
c)	Extra-terrestrial	Outer space material fall of meteoroids and asteroids on earth
d)	Biological	Living organisms
e)	Geophysical	Originate from earth's interior
f)	Climatological	Long lived meso and macro atmospheric processes

4. a) True

b) False

c) False

d) False

13.2

1. (i) River (ii) Flash (iii) Coastal

2. Fill in the blanks

Notes

a) Flood caused due to dam failure is because of Earthquake or human induced

b) The movement of wind in cyclones is anti- clockwise in Northern Hemisphere and clockwise in Southern hemisphere

c) Droughts are called Akal and Anavrishty in Hindi

d) Droughts cause scarcity of food and water.

3. The slipping of masses of rocks, earth or debris downwards on the mountain slopes or banks of the rivers is called a landslide.

4. Tsunamis

5 True and False

a) True

b) True

c) False

d) True

e) False

13.3

1. Match the following

S. no	Disaster	Area affected in percent
1	Drought	68 % land area
2	Earthquake	58.6 % land area
3	Floods	12% land area
4	Landslide and avalanche	15% land area
5	Cyclone and tsunami	8% land area

2. 85%

3. 12%

4. 283 districts

13.4

1. Disaster management includes-

   (i) Prevention,

   (ii) Mitigation,

   (iii) Preparedness,

   (iv) Response

   (v) Recovery and

   (vi) Rehabilitation. (any five)

2. Three stages of Disasters

   (i) Pre- Disaster

   (ii) On- Disaster

   (iii) Post- Disaster

13.5

1. Major plans and programmes adopted by government of India to control floods

   a) River Management Activities and Works related to Border Areas (RMBA)

   b) National Flood Commission

   c) National Commission for water resources

   d) National water policy 2012

2. Landslide Hazard Zonation -micro zonation on 1:10,000 scale

3. Three main measures adopted to control floods and also useful in cyclone prone areas

   a) Reservoirs

   b) Embankments

   c) Afforestation

13.6

1. Write the full form of the abbreviations

a) NDMA- National Disaster Management Authority

b) NDRF- National Disaster Response Force

c) SDMA's- State Disaster Management Authorities

d) DDMA's- District Disaster Management Authorities

e) WCDRR- World Conference on Disaster Risk Reduction

f) NIDM- National Institute Disaster Management

14

LAND AND SOIL RESOURCES

The nation's wellbeing, be it social, economic or political depends mostly on the available resources and their optimum utilisation. Resource is the matter or substance which satisfies human wants at a given time and space. Before any element can be designated as a resource three basic pre-conditions must be satisfied. They are; the knowledge, technical skills and demand for the material or services produced. If one of these conditions is not satisfied the particular substance remains unutilised. Let us explain it through one example. From time immemorial, water is present on the earth. But it became a source of energy when people acquired the knowledge and technical skills for hydel power generation. It is therefore human ability and need which gives importance to a particular resource and not their mere physical availability. So the basic concept of resources is also related to human well-being.

India is endowed with abundant resources. An integrated effort is being made in our country to make the best use of the existing resource potential. It helps to meet the demands of a growing population and also provides opportunities for employment. Simultaneously, it acts as an indicator for the levels of development. In this lesson we will study two vital resources i.e. Land and Soil.

OUTCOMES

After studying this lesson, learner:

- explains the significance and distribution of land and Soil resources;
- analyses the Land Use Pattern;
- discuss the characteristics of soil types with their uses;
- explains the problems related to land and Soil resources with suitable/appropriate solutions;
- suggests the methods of land resource management and Soil conservation.

Notes

14.1 LAND RESOURCES

Land is our basic resource. It includes all the features and processes of the land, which can be used to fulfil certain human needs. Throughout history, we have drawn most of our sustenance and much of our fuel, clothing and shelter from the land. It is useful to us as a source of food, as a place to live, work and play. It has different roles. It is a productive economic factor in agriculture, forestry, grazing, fishing and mining. It is considered as a foundation for social prestige and is the basis of wealth and political power. It has many physical forms like mountains, hills, plains, plateaus, lowlands and valleys. It is characterised by climate from hot to cold and from humid to dry. Similarly, land supports many kinds of vegetation. In a wider sense, land includes soil and topography along with the physical features of a given location. It is in this context that land is identified closely with the natural environment. However, it is also regarded as space, situation, factor of production in economic processes, consumption goods, property and capital. Soil is considered a core component of land resource and the foundation of all agricultural development and ecological sustainability. Soil is a complex, dynamic form of living system and its suitability varies from one region to another.

Before studying in details let us know shome of the important terminologies related to land use:

- Land under miscellaneous tree crops and groves include all cultivable land which is not included under net area sown, but is put to some agricultural use. Land under casuarina trees, thatching grass, bamboo, bushes, other groves for fuel, etc. which are not included under orchard are classed under this category.
- Forest area is land under natural or planted stands of trees of at least 5 metres in situ, whether productive or not, and excludes tree stands in agricultural production systems and trees in urban parks and gardens.
- Culturable Waste Land: This includes land available for cultivation, whether taken up or not taken up for cultivation once, but not cultivated during the last five years.
- Land Put to non agricultural Use: This category of land includes barren lands, uncultivable land put to non agricultural uses, land occupied by buildings, roads and railways or under water.
- Unculturable Land is which cannot be brought under cultivation except at an exorbitant cost is classified as unculturable whether such land is in isolated blocks or within cultivated holdings.
- Barren land : The land which cannot be used for cultivation is called barren land such as hilly terrains, deserts and ravines etc.

- Current Fallow : This is the land which is left without cultivation for one or less than one agricultural year. Following is a cultural practice adopted for giving the land rest. The land recoups the lost fertility through natural processes.

- Fallow Lands other than Current Fallows : This includes all land which was taken up for cultivation but is temporarily out of cultivation for a period of not less than one year and not more than five years.

- Net sown area is the total area sown with crops and orchards. It represents an area in which total crops are grown only once in a year.

India is well endowed with cultivable land which has long been a key factor in the country's socio-economic development. In terms of area, India ranks seventh in the world, while in terms of population it ranks second. Arable land includes net sown area, current fallow, other fallow and land under tree crops. Arable land covers a total area of 167 million hectares which is 51 % of the total area of the country.

The physical features in India are diverse and complex. There are mountains, hills, plateaus and plains which produce varied human response to the use of land resources. About 30% of India's surface area is covered by hills and mountains. These are either too steep or too cold for cultivation. About 25% of this land is topographically usable which is scattered across the country. Plateaus constitute 28% of the total surface area but only a quarter of this is fit for cultivation. The plains cover 43% of the total area and nearly 95% of it is suitable for cultivation. Considering the differences in proportion of surface area, we can conclude that about two third of the total land area is usable for cultivation. Moreover, soils, topography, moisture and temperature determine the limits of cultivability and the quality of arable land is determined by these factors. As a result of this, half of the surface area is cultivated. This proportion is one of the highest in the world.

14.2 LAND USE AND LAND USE PATTERN

Land Use is the function or functions that humans apply to the land available to them or in other words the various uses the available land is put into by human beings. The study of land use is the study of how the land is managed, according to human needs. The layout or arrangement of the uses of the land is referred to as "land use pattern". The land may be used for agriculture, forest, pasture etc. Land use is determined by physical factors such as relief, terrain, climate, soil, vegetation and Socio-Economic factors such as density of population, technical know how, skill and levels of literacy.

1. Out of the total geographical area (328 million hectares), land utilisation statistics are available for 305 million hectares only. The balance 23 million hectares remains unsurveyed and inaccessible. The relevant statistic is given in Table 14.1. From the

Notes

table it is clear that there are 5 major types of land utilisation in India. They are: Forest land, Net sown area, Land not available for cultivation, Fallow land and Other cultivable land excluding fallow land.

The significant features of land utilisation are:

(a) high percentage of area suitable for cultivation;

(b) limited scope for further extension of cultivation and

(c) small area under pastures despite a large bovine population.

Year	Geographical Area (Thousand Hectares)	Reporting area for land utilisation statistics (col.4+7+11+14+15)	Forests	Not available for cultivation			Other uncultivated land excluding Fallow Land				Fallow Lands			Net area Sown
				Area under non-agricultural uses	Barren & unculturable land	Total (col.5+6)	Permanent pastures & other grazing lands	Land under misc. tree crops & groves (not incl.	Culturable waste land	Total (col.8+9+10)	Fallow lands other than current fallows	Current fallows	Total(Col.12+13)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
2009-10	328726	307408	71555	26158	17177	43334	10340	3214	12945	26499	10838	16009	26847	139173
2010-11	328726	307483	71593	26400	17175	43575	10305	3200	12647	26152	10323	14277	24600	141563
2011-12	328726	307392	71599	26308	17217	43525	10314	3161	12637	26111	10665	14512	25177	140980
2012-13	328726	307491	71571	26503	17071	43573	10260	3181	12643	26085	11037	15292	26328	139934
2013-14	328726	307797	71828	26911	16943	43855	10265	3186	12387	25837	10694	14157	24851	141426
2014-15	328726	307781	71756	26942	16992	43934	10262	3104	12416	25782	11090	15091	26181	140128
2015-16	328726	307752	71866	27077	16945	44022	10261	3093	12286	25639	11308	15410	26718	139506
2016-17	328726	308316	72020	27838	16985	44823	10340	3124	12238	25702	11270	15086	26356	139415
2017-18	328726	307767	72047	27326	16992	44319	10338	3167	12287	25792	11621	14809	26430	139180
2018-19	328726	307787	72011	27344	17168	44512	10376	3154	12219	25749	11633	14531	26164	139351

Source: Land use statistics at a glance; 2009-10 to 2018-19; Ministry of Agriculture and farmers welfare department of Agriculture & Farmers Welfare Directorate of Economics & Statistics; November, 2021.

The above table portrays a timeline graph of various uses under which land has been put into. It's a trend from 2009-10 to 2018-19. We can very clearly observe that the Forest area has shown an increasing trend with the afforestation drives going on very seriously throughout the country. Permanent Pastures as well as Barren and unculturable land and Fallow land have seen a slight rise. There has been a decline in Net Sown Area although in between it did rise (2013-14 and 2014-15), this rise and fall is negligible. There is a remarkable rise in the category of land put to non-agriculture use. The decline in land put to agriculture, along with the rise of non-agricultural land can be attributed to the overgrowing population which requires land for institutional, residential, recreational purposes.

Land use is a dynamic process. The land use pattern of any area changes over time due to a number of factors such as increasing population, changes in cropping system and technology, socio-economic development etc.

Land Degradation

Land resources are under immense pressure in India due to growing demand from an exploding population and the impacts of climate change. Increase in demand on land resources is escalating manifold due to human needs. The ecosystem is also impacted as a result of this

Notes

pressure on land. All these factors lead to land degradation.

Land degradation is often defined as the long-term loss of ecosystems and their productivity caused by human activities which cannot be recovered unaided. It may also refer to the destruction or deterioration or depletion of the health of terrestrial ecosystems, thus affecting the associated biodiversity, natural ecological processes and ecosystem resilience. It also leads to the reduction or loss of biological/economic productivity of croplands, pasture, woodland, forest, etc. and various other types of land uses.

DO YOU KNOW?

It is estimated that during the last 40 years nearly one-third of the world's arable land has been lost to erosion and continues to be lost at a rate of more than 10 million hectares per year. -UNCCD Report

Fig. 14.1 Deforestation

The causes of land degradation can be broadly divided into two: the natural causes include earthquakes, tsunamis, droughts, avalanches, landslides and mudflow, volcanic eruptions, floods, tornadoes, and wildfires etc.; human induced causes include rapid urbanisation, deforestation, overgrazing, faulty irrigation practices, urban sprawl , pollution from industries, quarrying and mining activities.

Out of the total land area, as many as 175 million hectares suffer from degradation. Land degradation is caused largely by soil erosion, but also by water logging and excessive salinity. The most serious threat to the soil is posed by deforestation. Heavy rainfall during the monsoon damages the soils. Steep slopes encourage rapid runoff leading to soil erosion especially on the southern slopes of the Himalayas and the western slopes of the Western Ghats. Major portions of the Himalayas are prone to landslides and erosion. Wind erosion is prevalent in Rajasthan, gully erosion in Chambal Valley, Chotanagpur, Gujarat, Sub-montane Punjab Himalaya. Water logging and salinisation which constitute the second major threat to soil have already consumed 13 million hectares and threaten many more. The lands affected are mostly situated in canal irrigated areas. They have suffered because of the absence of adequate drainage. Land is also degraded due to mining operations in many parts of the country. The total land area affected is about 80 thousand hectares by mining. Urban encroachment on good quality agricultural land is another problem by which the amount of land used for agriculture is steadily declining. In other words, there is a tough competition between agriculture, urban and industrial development. There are social conflicts that are arising out of the rights to occupy and transfer of land. The tenant cultivators face major disincentives such as the fear of eviction, the insecurity of tenure, high rents and inadequate surplus to invest. Land ceiling laws have not been implemented with adequate strictness.

Land Resource Management

The major land problems include land degradation due to soil erosion, water logging, salinisation, mining operations and urban encroachment on good quality agricultural land. To deal with these problems, the country has adopted a two-fold approach; physical and social. Physical reclamation of land is achieved through developing sub-surface drainage systems of water-logged land and is followed by scientific rotation of crops. Similarly, land rendered useless by river action and river floods are also reclaimed after necessary treatment to restore their fertility and texture. Physical reclamation of desert lands calls for more sustained efforts. It requires introduction of suitable natural vegetation and a canal or well irrigation or even both. It helps to raise the water table. Social approach on the other hand is reflected through state legislation aiming at overall rural reconstruction, promoting agriculture and its productivity in particular. Consolidation of land holdings is one measure among many. It provides necessary motivation and empowerment of a tiller by confirming on him the rights of land tenure/ownership. Elements of social exploitation are promptly removed e.g. absentee landlords. Thus legislation is used to ensure social justice.

Remote sensing data have shown that about 200 square kilometres of the Gulf of Kachchh have been covered by sedimentation. The National Remote Sensing Agency has estimated 53 million hectares (16%) as wasteland in the country. Among the states and UTs the highest incidence of wastelands is recorded in Jammu and Kashmir (60%) followed by Rajasthan (38%), Sikkim and Himachal Pradesh (37% each) and Gujarat (17%). The Government of

India constituted the National Wasteland Development Board in 1985 with a view to enhancing productivity of wastelands. It includes the programe of afforestation of 5 million hectares per year. India does not have a shortage of land. But, land reform policies need to be reoriented for further increase in food production.

There is a need to achieve Zero Net Land Degradation (ZNLD) which means the achievement of a state of land degradation neutrality. Achieving it involves a combination of reducing the rate of further degradation of land and offsetting newly occurring degradation by restoring the productivity and other ecosystem services of currently degraded lands.The ZNLD is best achieved by the introduction and promotion of Sustainable Land Management(SLM) practices on a global basis.

Sustainable Land Management practices include the integrated management of crops (trees), livestock, soil, water, nutrients, biodiversity, disease and pests to maximise the delivery of a range of ecosystem services. The objective is to maximise provisioning services (e.g. food, water, energy) while enhancing the resilience of land resources and the communities which depend on them. Adopting simple and affordable techniques which can stop land degradation and replicating them at the global level can have a major impact. Practices such as agro-forestry and sustainable agriculture, can boost yields and prevent future land degradation. For example- In Zimbabwe, water harvesting combined with conservation agriculture increased farmers' gross margins 4-to-7-fold and increased returns on labour 2-to-3-fold compared to standard practices. These practices have had the greatest success in regions with lower rainfall.

To fulfil the demand of increasing population, rather than bringing new land under managed ecosystems, productivity should be enhanced from land that is already devoted to agricultural production. While enhancing productivity from land already under production through land restoration, laws and policies and educational programs must also be followed to protect/ preserve/conserve natural ecosystems against indiscriminate cutting of firewood, grazing, etc. Protection and enhancement of vegetation cover are essential to control soil erosion. Afforestation of denuded lands with adaptable species is essential to conserve soil and water which also helps in strengthening the nutrient cycle.

Community-Based Traditional Approaches - There is an increasing realisation that local communities have an important role to play in land management. Customary SLM practices in forested, agricultural and pastoral regions are prevalent in many parts of India. These practices are jointly supported by government policies/programmes and also by local community participation. These regulatory frameworks have the potential to reduce the causes and effects of Land degradation processes.

Some of the measures to prevent degradation and restore degraded lands are mentioned below:

Notes

- Afforestation as well as reforestation
- Sustainable pastures and livestock management
- Narrow strip planting, Use of Windbreaks and Shelterbelts
- Optimum utilisation of water for irrigation
- Proper use of fertilisers and pesticides
- Growing salt tolerant soils in saline land
- Sustainable mining practices
- Proper discharge of industrial effluents
- Proper management of wastelands

INTEXT QUESTIONS 14.1

1. Name any five types of land use.
2. Name the land which is left without cultivation for one or less than one agricultural year.
3. What are human induced causes for land resource degradation?

14.3 SOIL RESOURCES

Soil is defined as the upper layer of the earth composed of loose surface material. It is a mixture of many substances including an endless variety of minerals, remnants of plants and animals, water and air. It is the end product of continuing interaction between the parent material, local climate, plant and animal organisms and elevation of land. Since each of the elements varies over space, soils also differ from place to place. Soil is an important segment of our ecosystem, as it serves as an anchorage for plants and a source of nutrients. Thus, soil is the seat, the medium and fundamental raw material for plant growth. Through its relative fertility, it affects man's economic activities and shapes the destiny of our country. When the soil is lost, property and culture are also lost. Therefore, it is a valuable national and fundamental earth resource of the country.

A Soil Profile

A soil profile is a vertical cross-section of the soil, made up of many layers running parallel to the surface. These layers are known as soil horizons. The soil is arranged in a number of layers or horizons during its formation process. Thus the Soil Profile consists of layers or horizons.

Soils typically have six horizons. From the top down, they are Horizon O,A,B,C and R. Each horizon has certain characteristics. O Horizon is the top most layer, made up mostly of leaf litter and fresh organic matter. The A Horizon is made up of decomposed organic matter, micro organisms such as earthworms, fungi, bacteria etc. The B Horizon consists of less humus, but more minerals. The C Horizon is made up of broken bed rocks and R Horizon is the compact bedrock region.

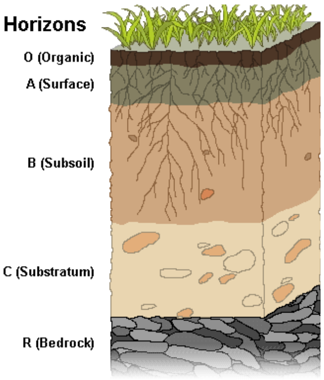


Fig. 14.2 Soil profile

B. Major Soil Types and Distribution

The soils of India are broadly divided into following six types:

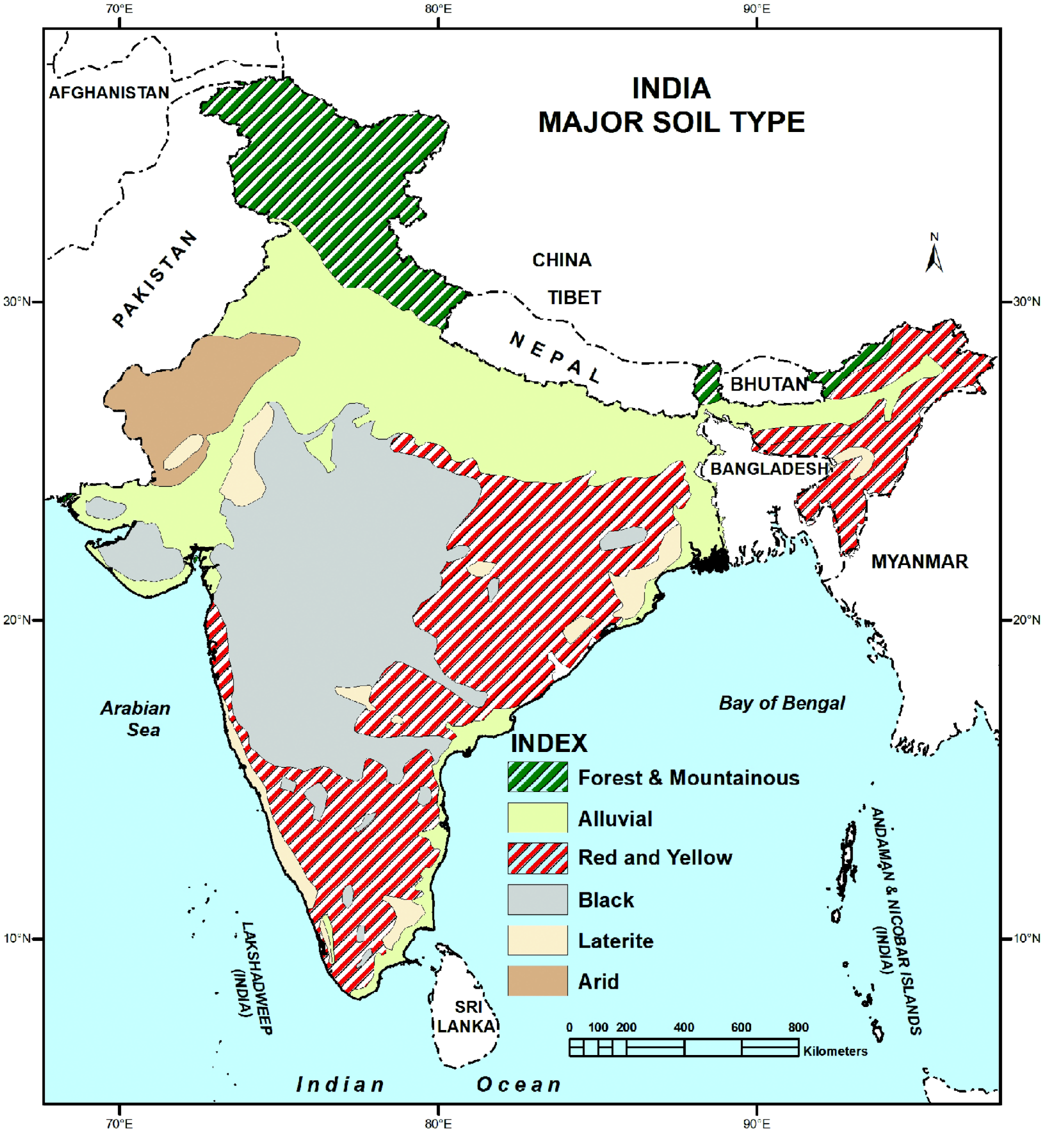


Fig. 14.3 India: Major soil resourece

1. Alluvial Soils

Alluvial soil is the most important soil type of India. It covers the vast valley areas of the Sutlej, Ganga and Brahmaputra and the fringes of the southern peninsula. It is thin near the fringe of the plateau. The alluvial soils occupy 64 million hectares of the most fertile land. The soils vary from sandy loam to clay in texture and are rich in potash but deficient in nitrogen and organic matter. Generally, the colour varies from grey to reddish brown. These soil are formed of deposits of silt and sand brought down by the rivers flowing from the Himalayas and the Great Indian plateau. Being young, the soils lack profile development. Being extremely productive, these soils are most important from the point of view of Indian agriculture. Based on geographical considerations, this soil can be subdivided into two divisions: newer alluvium (khadar) and older alluvium (bangar). Both are different in texture, chemical composition, drainage capacity and fertility. The newer alluvium is a light friable loam with a mixture of sand and silt. It is found in river valleys, the floodplains and deltas. On the other hand, the older alluvium lies on the interfluves. The higher proportion of clay makes the soil sticky and drainage is often poor. Almost all crops are grown on these soils.

2. Black Soils (Regur)

The black soils are found mainly in the Deccan lava region covering large parts of Maharashtra, some parts of Gujarat and Madhya Pradesh and small parts of Karnataka, Telangana, Andhra Pradesh and Tamil Nadu. The soils are formed by disintegration of volcanic basaltic lava. The colour of the soil is generally black due to the presence of compounds of aluminium and iron. The soil is locally known as regur which extends roughly to 64 million hectares. It is generally clayey deep and has low permeability and impregnability. But its depth varies from place to place. It is very thick in lowlands but very thin on highlands. The most important characteristics of this soil are its ability to retain moisture even during the dry season. The soils form wide cracks during summer due to moisture loss and swell and become sticky when saturated. Thus, the soil is aerated and oxidised to deep levels which contribute to maintaining its fertility. This continued fertility is favourable in the area of low rainfall for cotton cultivation even without irrigation. Other than cotton, this soil is favourable for the cultivation of crops like sugarcane, wheat, onion and fruits.

3. Red Soils

Red soils cover a large part of the Peninsular upland in Tamil Nadu, Karnataka, Goa, South east Maharashtra, Telangana, Andhra Pradesh, Orissa, Chotanagpur Plateau and Meghalaya Plateau. They encircle the black cotton soil zone. They have developed on the crystalline rocks like granite, gneisses and cover roughly 72 million hectares of the arable land. Iron compounds are abundant making the soil reddish in colour but

they are deficient in organic matter. The red soils are generally less fertile and are not as important agriculturally as the black and alluvial soils. But the productive capacity can be raised through irrigation and use of fertilisers. This soil is suitable for rice, millet, maize, groundnut, tobacco and fruits.

4. Laterite Soils

The laterite soils are commonly found in areas of high altitude and heavy rainfall in Karnataka, Tamil Nadu, Madhya Pradesh, Jharkhand, Orissa, Assam and Meghalaya extending over 13 million hectares. They generally form under hot and humid climatic conditions.The lateritic soils are particularly found on high flat erosion surfaces in areas of high and seasonal rainfall. Loss of nutrients by accelerated leaching is the most common feature which renders the soil infertile. The pebbly crust is the important feature of laterites which is formed due to alteration of wet and dry periods. As a result of weathering, laterite becomes extremely hard. Thus, their characteristics include complete chemical decomposition of the parent rock, complete leaching of silica, a reddish brown colour given by the oxides of aluminium and iron and lack of humus. The crops which are generally grown are rice, millets, sugarcane on lowland and tropical plantations such as rubber, coffee and tea on uplands.

5. Desert Soils

The desert soils occur in western Rajasthan, Saurashtra, Kachchh, western Haryana and southern Punjab. The occurrence of these soils is related to desert and semi-desert conditions and is defined by the absence of water availability for six months. The soil is sandy to gravelly with poor organic matter, low humus contents, infrequent rainfall, low moisture and long drought season. The soils exhibit poorly developed horizons. Plants are widely spaced. Chemical weathering is limited. The colour of the soil is either red or light brown. Generally, these soils lack the basic requirements for agriculture, but when water is available, a variety of crops like cotton, rice, wheat etc. can be grown with a proper dose of fertilisers.

6. Mountain Soils

The mountain soils are complex and extremely varied. The soils vary from deep alluvium in the river basins and lower slopes to highly immature residual gravel on higher altitudes. Because of complex topographic, geologic, vegetation and climatic conditions, no large areas of homogenous soil groups are found. Areas of steep relief are mostly devoid of soil. Various types of crops are grown in different regions like rice in the valley, orchards on slopes and potatoes in almost all areas.

Notes

C Problems of Soil Resources

Soil erosion is described as the carrying away of soil. It is the theft of the soil by natural elements like water, wind, glaciers and waves. Gravity tends to move soil down slope either very slowly as in soil creep or very rapidly as in landslides. The present shape of land has been carved through thousands of years. Soil erosion has become now one of the major environmental problems and a serious constraint for agricultural production. There are many physical and social factors which determine the extent and severity of soil erosion. The principal physical factors are erosivity of rainfall, erodibility of soil, severity of periodic floods, length and steepness of the slope. The important social factors are deforestation, overgrazing, nature of land use and methods of cultivation.

Ravines, gullies and landslides are the most serious and highly visible forms of soil erosion. On the other hand, sheet erosion caused by rains and erosion due to winds are least visible but equally serious as they too take a heavy toll on our precious top soils. Soil erosion by ravines and gullies is widespread in India, It has been estimated that 3.67 million hectares of soil surface is damaged. There are four major areas of ravines and gullies in India. They are (1) Yamuna-Chambal ravine zone, (2) Gujarat ravine zone, (3) The Punjab Siwalik foothills zone and (4) Chhotanagpur zone. There are other areas of substantial ravine erosion in the Mahanadi valley, upper Son valley, upper Narmada and Tapi valleys, Siwalik and Bhabar tract of the western Himalayan foothills and edges of Ganga Khadar in western Uttar Pradesh. The relatively less affected areas are the whole of Deccan south of the Godavari, the Ganga-Brahmaputra plains, east of Varanasi, Kutchchh and western Rajasthan.

Sheet erosion is widespread over sloping deforested terrain, terraced uplands of Peninsular region, Sutlej-Ganga plains, Coastal plains, Western Ghats and NorthEastern hills. The occurrence of landslides is common in earthquake sensitive belts, particularly the Siwaliks. Heavy rainfall and cutting of slopes for roads, buildings and mining activities trigger landslides. Glacial erosion is limited to high Himalayas and sea erosion is confined to coastal areas only. In the last 50 years, the Thar desert has encroached upon 13000 hectares of land in Rajasthan, Gujarat, Haryana and Uttar Pradesh.

Soil erosion and soil exhaustion due to loss of soil nutrients pose serious threats to our efforts of increasing the productivity of soil faster than the population growth. Overgrazing by sheep, goats and other livestock has been partly responsible for soil erosion. Erosion due to these factors has been reported from Jammu & Kashmir, Himachal Pradesh, Rajasthan and Karnataka.

INTEXT QUESTIONS 14.2

1. What is a soil profile?
2. The soils of India are broadly divided into how many types? Name them.
3. Based on geographical considerations, Alluvial soil can be subdivided into how many divisions? Name them.
4. Why the colour of the 'regur soil' is generally in black colour?

14.4 SOIL CONSERVATION

It takes thousands of years for a single inch of soil to be formed naturally, but it takes only a few years for that single inch to be eroded by human interference. If the soil is wasted or blown away, it is not easy to replenish it. Soil conservation is the prevention of loss of the top most layer of the soil from erosion or prevention of damaged fertility caused by over usage, acidification, salinization or other chemical soil contamination. The most important step of soil conservation is to hold the soil in place. This is possible by improved agricultural practices in different regions. Contour ploughing and terracing are generally practised on the hill slopes of the Himalayas. They are the simplest conservation methods. Rows of trees or shelter belts are planted to protect the fields from wind erosion in desert regions of Rajasthan. Afforestation of the river catchment areas and in steep slopes has been implemented in many parts of India. The important among them are: the Himalayas, the Upper Damodar valley in Jharkhand, the Nilgiri hills in the south etc. It reduces the surface runoff and binds the soil. Ravines are noted for their enormous size and depth with vertical sides. The Central Soil Conservation Board has established 3 research stations: (1) Kota in Rajasthan, (2) Agra in Uttar Pradesh and (3) Valsad in Gujarat to suggest methods of reclamation of ravine lands. Soil fertility loss can be prevented by the application of manures and fertilisers.

Various methods for soil conservation are:

1. Planting more and more trees.
2. Using new farming methods.
3. Reducing rivers flooding.
4. Building small check dams in gullies to slow down water run-off.
5. Digging channels across farm slopes to divert water.
6. Protecting areas likely to be eroded.

Notes

7. Checking deforestation.
8. Contour ploughing terrace farming.
9. Restore wetlands
10. Planting vegetaion cover and forest restoration
11. Planting buffer strips along stream banks
12. Windbreaks
13. Proper waste disposal and management

14.5 SOIL HEALTH CARD

Soil Health Card (SHC) is a printed report of a particular land holding which gives information on 12 soil parameters along with recommendation in dosage of nutrients to be utilised for different crops. On 5th December 2015, the Soil Health Card Scheme was introduced by the Ministry of Agriculture and Farmers' Welfare, Government of India. It is being implemented through the Department of Agriculture of all the State and Union Territory Governments in India. Under the scheme, the card is provided to all farmers of the country at an interval of 3 years.

Significant features of Soil Health Card Scheme are:

- The Government issues individual soil cards to farmers once every 3 years.
- Cards carry crop-wise recommendations of nutrients and fertilisers in the respective individual farms. These recommendations aim at improving productivity through judicious use of inputs.
- To deliver the recommendations Soil samples are collected and tested in various soil testing labs across the country. After testing, various experts analyse the strength and weaknesses of the soil and suggest measures to deal with it. The result and suggestion are displayed in the cards.
- The soil samples are tested for 12 parameters. They are pH, Electrical Conductivity (EC), Organic Carbon (OC), Nitrogen (N), Phosphorus (P), Potassium (K), Sulphur (S), Zinc (Zn), Boron (B), Iron (Fe), Manganese (Mn), Copper (Cu) of farm holdings.

The benefits of Soil Health Cards are:

- It decreases 8 to 10 per cent use of chemical fertilisers
- It increases productivity by 5 to 6 per cent.
- It creates job for the agrarian youths in terms of laboratory establishment to undertake soil testing
- It curbs the overuse of urea which leads to the deficiency of many soil nutrients.
- It gives crop wise guidance to farmers.

The card displays farmer's detail, soil sample detail, soil test results and general recommendations. The sample of the Soil Health Card is given below.

Department of Agriculture & Cooperation
Ministry of Agriculture & Farmers Welfare
Government of India

Directorate of Agriculture
Government of Goa

SOIL HEALTH CARD

Soil Health Card No. : ____________

Name of Farmer : ____________

Validity : From ________ To ________

SOIL HEALTH CARD	
Farmer's Details	
Name	
Address	
Village	
Sub-District	
District	
PIN	
Aadhaar Number	
Mobile Number	
Soil Sample Details	
Soil Sample Number	
Sample Collected on	
Survey No.	
Khasra No. / Dag No.	
Farm Size	
Geo Position (GPS)	Latitude: Longitude:
Irrigated / Rainfed	

Name of Laboratory ____________

SOIL TEST RESULTS				
S. No.	Parameter	Test Value	Unit	Rating
1	pH			
2	EC			
3	Organic Carbon (OC)			
4	Available Nitrogen (N)			
5	Available Phosphorus (P)			
6	Available Potassium (K)			
7	Available Sulphur (S)			
8	Available Zinc (Zn)			
9	Available Boron (B)			
10	Available Iron (Fe)			
11	Available Manganese (Mn)			
12	Available Copper (Cu)			

Secondary & Micro Nutrients Recommendations		
Sl. No.	Parameter	Recommendations for Soil Applications
1	Sulphur (S)	
2	Zinc (Zn)	
3	Boron (B)	
4	Iron (Fe)	
5	Manganese (Mn)	
6	Copper (Cu)	
General Recommendations		
1	Organic Manure	
2	Biofertiliser	
3	Lime / Gypsum	

International Year of Soils 2015

Healthy Soils for a Healthy Life

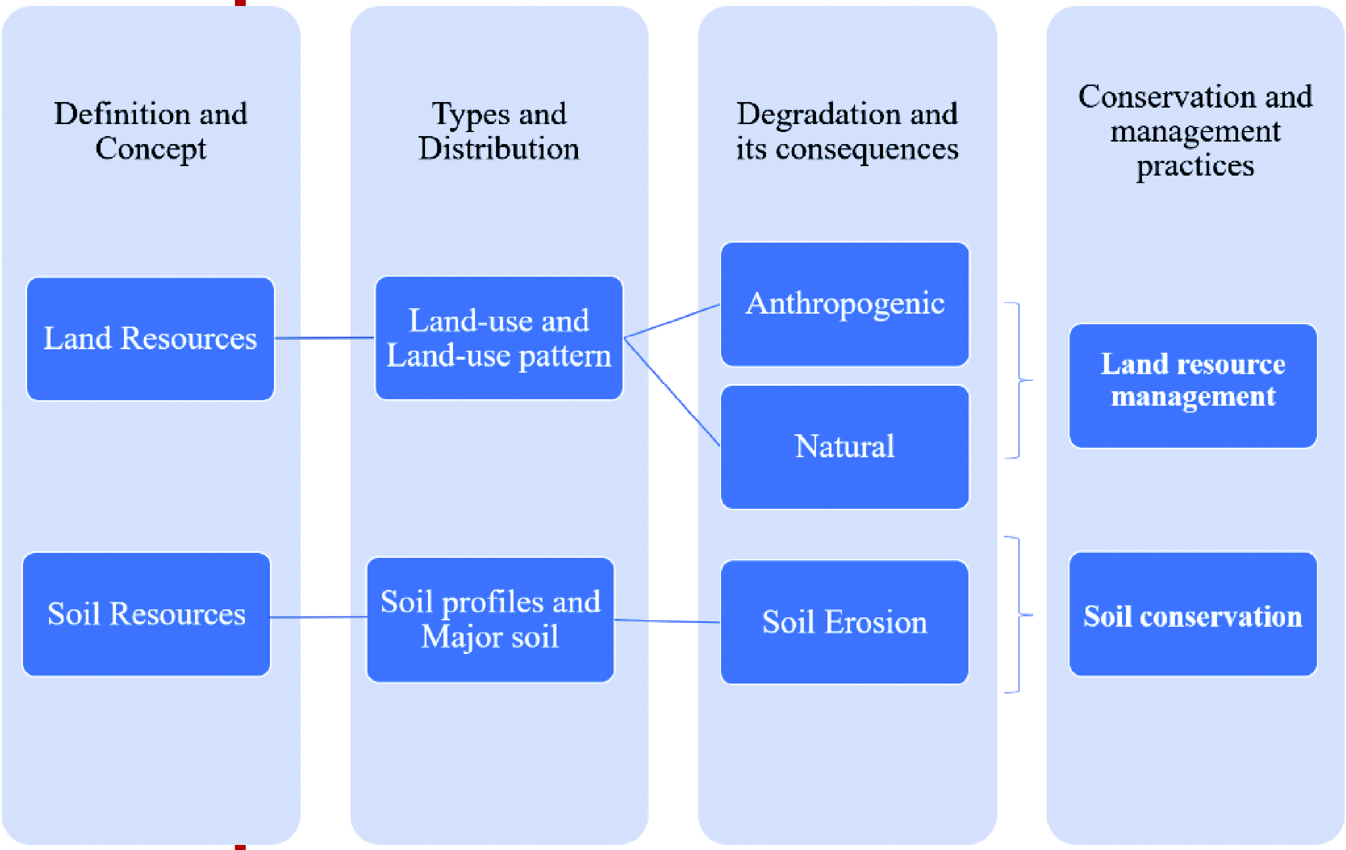
Fertilizer Recommendations for Reference Yield (with Organic Manure)				
Sl. No.	Crop & Variety	Reference Yield	Fertilizer Combination-1 for N P K	Fertilizer Combination-2 for N P K
1	Paddy (Dhaan)			
2				
3				
4				
5				
6				

Fig. 14.4 Soil Health Card

INTEXT QUESTIONS 14.3

1. What is the soil Health Card (SHC)?
2. What are the measures to conserve soils?
3. In which year SHC was introduced?

WHAT YOU HAVE LEARNT



TERMINAL QUESTIONS

1. What are the significant features of land utilisation in India?
2. Give a brief description of various types of land use in India.
3. Write two main characteristics of each soil type of India.
4. Describe various measures undertaken for conservation of soils.

5. Differentiate between:

   (a) Laterite soil and red soil

   (b) Soil erosion and soil conservation

   (c) New alluvium and old alluvium

6. Locate and label the following on an outline map of India:

   (i) Alluvial soil.

   (ii) Laterite soil.

   (iv) Desert soil.

ANSWERS TO INTEXT QUESTIONS

14.1

1. Forest land, Net sown area, Land not available for cultivation, Fallow land, Other cultivable land excluding fallow land (any 3)

2. Current Fallow

3. Rapid urbanisation, deforestation, overgrazing, faulty irrigation practices, urban sprawl, pollution from industries, quarrying and mining activities.

14.2

1. A soil profile is a vertical cross-section of the soil, made up of many layers running parallel to the surface.

2. Six (6); Forest and mountainous soil, alluvial soil, laterite soil, black soil, red soil and desert or arid soil.

3. Two divisions, named Bangar (older alluvium) and Khadar (newer alluvium).

4. Due to presence of Aluminium and Iron.

14.3

1. Soil Health Card (SHC) is a Government of India's scheme promoted by the Department of Agriculture & Cooperation under the Ministry of Agriculture and Farmers' Welfare. It is being implemented through the Department of Agriculture of all the State and Union Territory Governments in India.

Notes

2. i. Planting more trees

   ii. Using new farming method

   iii. Reduce river flooding

   iv. Checking deforestation (Any 3)

3. 2015

15

FORESTS AND BIODIVERSITY

Forest refers to an area covered with trees or a dense growth of trees and underbrush covering a large tract. The Latin word 'Foris' means the outer part of settlements. The importance of forests for our survival is of many folds - from air we breathe to the timbre from wood we use. Forests provide habitats for wildlife and livelihoods for humans. Forests also offer watershed protection, prevents soil erosion and landslides and helps in mitigating climate change. In this lesson you will learn about the importance of forests, distribution of forest resources, methods of forest conservation etc.

OUTCOMES

After studying this lesson, learner:

- describes the importance and use of forest resources and their distribution;
- explains the flora and fauna and biodiversity hotspots;
- analyses the methods of forest conservation and
- appreciates community development initiatives with special reference to joint forest management strategies.

15.1 FOREST RESOURCES

Forest resources are of paramount importance for all living beings.Forests provide us with food, shelter, livelihood, fuel security and water. Over 2 billion people rely on forests either directly or indirectly in the world. Major parameters used for measuring forest resources are forest cover, species composition, timbre and non-timber products, annual increment, growing stock, biodiversity etc.

DO YOU KNOW?

The International Day of Forests (World forest Day) is celebrated every year on 21st March to spread awareness about the environment. Since 2013, Government of India observes 11th September as 'National Forest Martyrs Day' to pay tribute to the valour and sacrifice made by forest personnel to protect the forests and wildlife of India.

Significance of forest

Forest have very significance role on the earth. You can find its significance as:

- Forests are the world's second largest storehouse of carbon after oceans. They are also the source of oxygen. They provide services like absorbing greenhouse gases, protecting watersheds and reducing or slowing the soil erosion etc.
- Forests are like giant sponges where trees and soil help in ground water recharge; and feeds rivers, ponds, lakes and springs; reduces runoff and chances of floods. Forests regulate precipitation; they also emit biological particles like pollen and fungal spores which act as condensation nuclei for raindrop formation.
- Forests are natural cooling systems as trees use solar energy to evaporate moisture and have a cooling effect on the environment. They help in slowing global warming as they act as carbon sinks and also purify air from carbon monoxide, sulphur dioxide, nitrogen dioxide and fine dust. Forests near urban settlements help in reducing the 'heat island' impact of urban activities and transportation.
- Forests control many disasters like controlling river floods especially flash floods and Mangrove forests act as wind breakers in cyclone prone areas. They also help in reducing risk from landslides, avalanches and sand storms. It helps in preventing droughts.
- Forests provide habitats to diverse animal species. They are home for more than 80% of world terrestrial biodiversity and livelihood for different types of settlements including 60 million indigenous people.
- Forests are of great economic value worldwide; it is estimated at 16.2 trillion dollars. Forests create jobs for 13 million people in the world. Forests play an important role in tourism. Third of the world's population still depends on forests and trees for their daily needs, especially for heating and cooking.
- Forests are also vital for health; they provide a treasury of medicinal plants and pharmaceutical ingredients and fresh air for oxygen-rich walks.

Notes

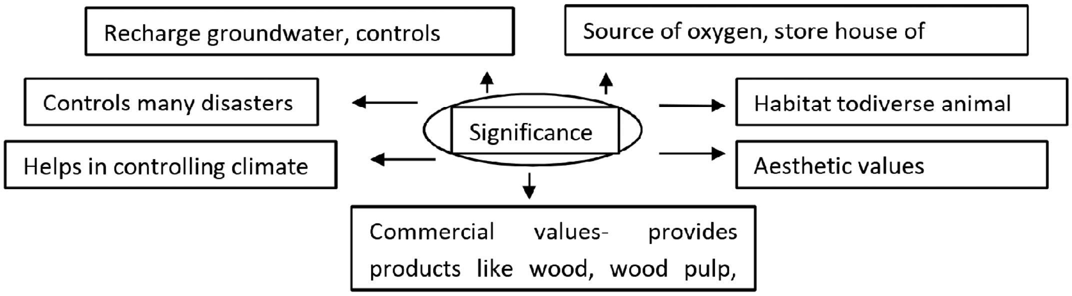


Fig 15.1 Significance of forests

15.2 FOREST OF INDIA

As in any other part of the world, forests of India are determined by climate, physiographic condition and soil types. Factors affecting different types of forest are temperature, precipitation, gradient of land, slope aspect, depth and texture of soil etc. Having great variation in all these factors, India has great diversity of forests. The forests of India can be broadly divided into the following groups:

A Tropical Evergreen Forests

B Tropical Deciduous Forests

(a) Tropical Moist Deciduous

(b) Tropical Dry Deciduous

C Thorn Forests

D Tidal Forests and Littoral and Swamp forests

E Himalayan Forests and southern Montane forests

A. Tropical Evergreen and Semi evergreen forests

Trees in these forests remain green all the year round as the climate of the region is warm and wet throughout the year. A large number of species spread over this region. No specie dominates large areas along with under growing climbers. Different species shed their leaves in different seasons. Hence, the forest looks evergreen throughout the year. These forests are found in the areas having more than 200 cm of rainfall with a short dry season. The mean annual temperature remains above 20^{o} C in this region.The trees reach a height up to 60 metres or even more.The forest has a dense and mixed vegetation of all kinds including trees, shrubs, climbers, creepers, epiphytes and ferns giving it a multilayered structure. Hence, their economic exploitation is not viable. The number of species of trees is very large in a small area. Rosewood, ebony, mahogany, rubber, jack wood, kail, white cedar and bamboo are the important species of trees

found in Tropical Evergreen Forests. In India, this type of vegetation is found in the areas of heavy rainfall in western slope of Western Ghats, upper parts of Assam and hills of north eastern regions and islands of Lakshadweep and Andaman and Nicobar. Hardwood from these forests is used for furniture, handicraft etc. They prevent landslides and soil erosion. Some forest areas are cleared for plantations crops like tea, coffee and rubber

B. Tropical Deciduous Forests

Broadly, divided into two categories of Tropical Moist Deciduous and Tropical Dry Deciduous. Trees in these forests shed their leaves once a year. That is why they are called tropical deciduous forests. These are the most widespread forests of India. These forests are found in the areas receiving annual rainfall between 75 to 200 cm and many times called 'Monsoon forests'. As far as the physical distribution of this type of forests is concerned, they are found in the entire country excluding some parts of Deccan Plateau, North-Eastern Region, Western Ghats and Eastern coast. One species of trees found in large numbers together making them most viable for economic exploitation. The deciduous forests are the most economically exploited forest types in India. These forests have been subject to extensive clearance by humans for the purpose of cultivation. Still some patches of natural vegetation are found along the foothills of Himalayas, hilly regions of peninsular and central part of the country. On the basis of the availability of rainfall these forests are further divided into moist deciduous and dry deciduous.

(a) The moist deciduous forests are found in the areas receiving 100 to 200 cm of rainfall. These are distributed mainly in the eastern parts of the country, North eastern states along the foothills of Himalayas, Jharkhand, Odisha and Chhattisgarh, and eastern slopes of Western Ghats. Teak, Bamboo, Sal, Shisham, Sandalwood, Khair, Kusum, Arjun, Mahua, Jamun and Mulberry are the important species of trees found in these forests.

(b) The dry deciduous forests are spread in the areas receiving annual rainfall between 75 to 100 cms annually. These forests are found in the interior parts of the peninsular plateau and the plains of Uttar Pradesh, Madhya Pradesh and Bihar. Tree species of this forest are Teak, Sal, Tendu, Bel, Amaltas, Peepal, and Neem. In the dry season most trees shed their leaves completely and the forest looks like vast grasslands. Dry grass sometimes catches fire either due to natural causes or by human negligence.

C. Thorn Forests

The areas with less than 75 cm of annual rainfall are characterised by the natural vegetation of thorny trees and bushes. Climate of this part is mainly dry with occasional wet periods,

so it does not support dense vegetation. They are mainly found in North-Western India, interior parts of the Peninsular India including semi arid areas of Gujarat, Rajasthan, Madhya Pradesh, Chhattisgarh, Uttar Pradesh, Haryana, Karnataka, Andhra Pradesh and Maharashtra. Vegetation of these forests is widely distributed in the form of small trees and bushes with deep roots. The stems are succulent to conserve water. Leaves are mostly thick and small to minimise evaporation and many plants and trees have thorns to preserve water and reduce evaporation. Acacia, euphorbias, babul, cacti, khair, date and palms are common variety of trees in this type of vegetation among grasses. Tussocky grasses have roots which can go down to 2 m deep are also seen abundantly growing in thorn forests.

D. Tidal or Mangrove Forests

As suggested by the name, tidal forests are found in tidal creeks and swamps influenced by the tides and wetland topography. These areas are characterised by mud, silt and water accumulated on the surface. Roots and branches of the trees are submerged under water for a specific period of time. They are also called mangrove forests. Mangroves are practically evergreen with thick leathery leaves. Such types of forests are found in the deltas of Sundarbans, Mahanadi, the Godavari, Krishna, Kaveri rivers and in the Andaman and Nicobar Islands. Mangrove or Sundari is the common tree in Sundarbans while palm, coconut, keora, and agar are other important species of tidal forest. Mangrove spread over 6,740 sq. km accounting for 7 percent of world's mangrove forests. It is interesting to know that this type of forest has remained away from large -scale commercial exploitation. These forests are located along the coasts. They provide protection against cyclones.

Along with tidal forests other similar types of forest are Littoral and Swamp forests which have an abundant variety of wetland habitats. Such forest areas witnessed 70% land use conversion into paddy cultivation. Wetlands sites are identified as Ramsar sites.

E. Montane Forest

These forests are mainly found in the Himalayas. The decreasing in temperature and increasing in altitude lead to varied types of vegetation. Other important factors like slope of the mountain and sun facing side of the slope influence the vegetation. The ecosystem is highly fragile. Himalayan forests have been exploited in many ways in recent decades. Areas with relatively low altitude up to 1000 metres, warm climate and good amount of rainfall are characterised by dense vegetation cover. These areas look like tropical forest. Sal and Bamboo are main species in these areas. Between the elevation of 1000 to 2000 metres, evergreen broad leaves Oak and Chestnut are the common species found in these forests. In easternHimalayas the same elevation is

occupied by subtropical Pine forests. Chir is common species found in this part. Moist temperate forests in Himalayas are found between the elevation 1500 to 3500 metres which receives annual rainfall in the range of 100 to 250 cm. Oak, laurel, chestnut, cedar, Silver, Firn, spruce rhododendron and deodar are the main species found in this part of Himalayas. They have been widely exploited for their timber.Alpine forest found in Himalayas at the height of 3000 to 3800 mts with large and extensive highland grassland and sparsely distributed pine, birch, sliver, fir and rhododendron trees.

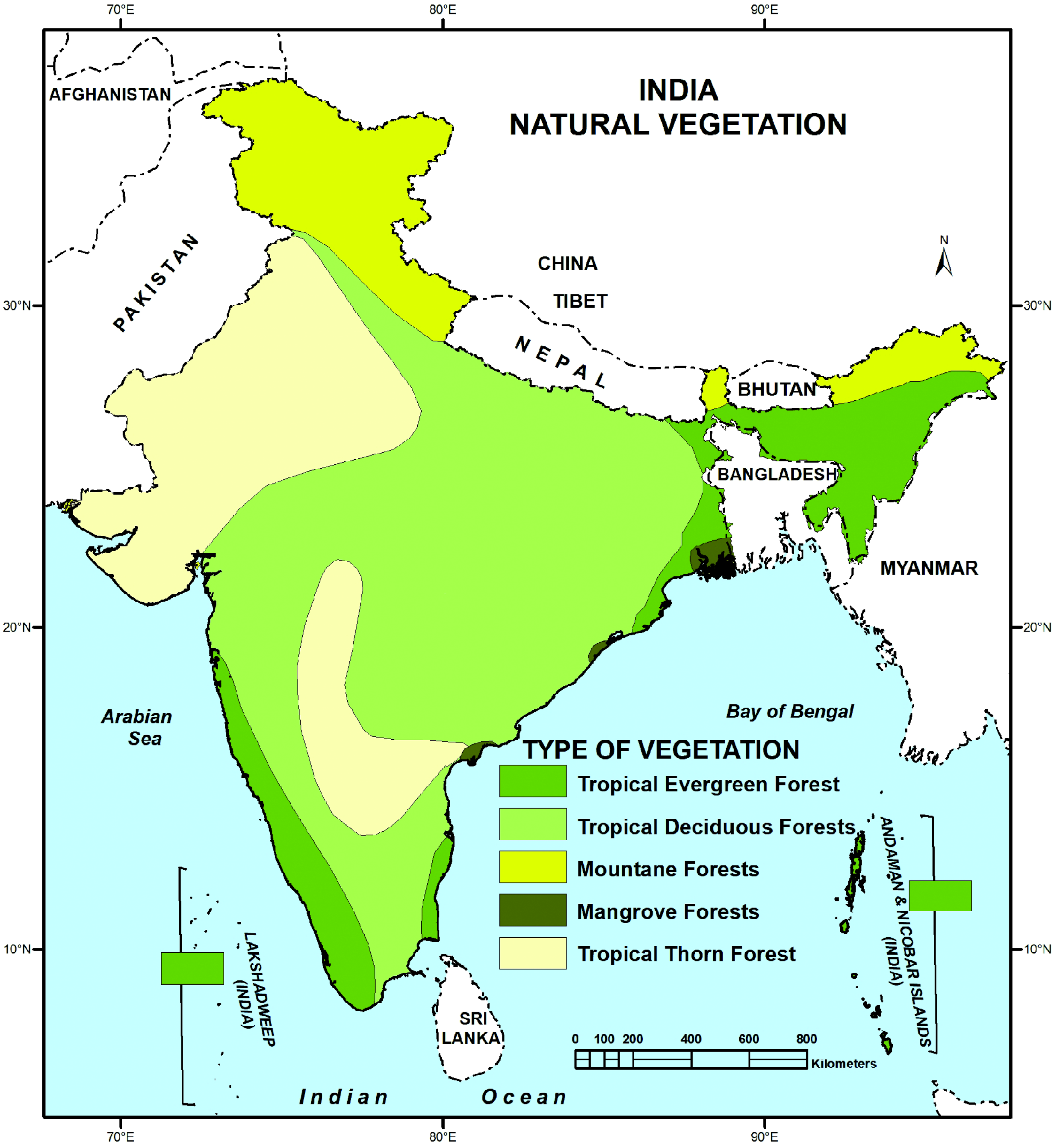


Fig. 15.2 India: Natunal Vegetation

Montane forests are also found in the southern part of India. The three distinct areas of Peninsular India where these forests are found are:

(a) The Vindhyas including Satpura and Maikal ranges (Madhya Pradesh, Chhattisgarh, and the Chota Nagpur region): These are generally moist deciduous forest zones with sal and teak.Patches of dry deciduous forests or scrubs are also found.

(b) Nilgiris (Nilgiris, Anaimalai and Palani hills): The temperate forests in Nilgiris are called 'Sholas'. Major trees species found are laurel, magnolia, wattle, cinchona and others which have great economic importance

(c) The Western Ghats or the Sahyadris (Kerala, Tamil Nadu And Karnataka):The areas have temperate vegetation in higher regions and sub- tropical in lower elevations.

According to state records, 23.28 per cent of the total land area of India is under the forest cover. The better indicator to get the correct picture of the actual forest cover is by assessing the area with canopy cover. According to India State of Forest report 2011, the actual forest cover in India is 21.05 per cent. The share of dense forest is 12.29% and open forest is 8.75%. Lakshadweep has zero forest area whereas Andaman and Nicobar have 86.93 % of land area covered by forests. The north and north western states have less than 10% area under forest cover.They are Gujarat, Punjab, Rajasthan, Haryana and Delhi. Large areas of Punjab and Haryana are under cultivation, so these states have very less forest cover. Tamil Nadu and West Bengal have 10-20 % land under forest cover. Except for Tamil Nadu, Goa and UT of Dadra and Nagar Haveli most of peninsular India has 20-30 % of land under forest. The North- eastern states have more than 30% of land area under forest. Good rainfall and varied terrain supports good forest growth in this region of the country.

The Forest Survey of India (FSI) have classified the forest areas into 4 broad classes as following

Very dense	All forest with tree cover (including mangrove cover) of canopy density 70% and above
Moderately Dense Forest	All forest with tree cover (including mangrove cover) of canopy density 40% and 70%
Open forest	All forest with tree cover (including mangrove cover) of canopy density 10% and 40%
Scrub	All forest lands with poor tree growth mainly of small or stunted trees having canopy density less than 10 percent
Non forest	Any area not included in above classes

The classification of the forest area into dense and open forests is based on internationally adopted norms of classification. Mangroves are separately classified because of their characteristic tone and texture and unique ecological functions.

15.3 FLORA AND FAUNA OF INDIA

India has 2.4% of the world's total land area, accounting for 7-8% of all recorded species, including species of animals and plants. Due to India's unique geographical position, it is endowed with rich reserves of flora and fauna as there are varied terrain, climate, soils, water resources etc.

India has rich flora ranking 10th in the world and 4th in Asia in regard to its diversity. Many plants synthesise substances that are useful for the maintenance of health in humans and other animals. The Botanical Survey of India (BSI), Kolkata have surveyed 70% of the geographical area of India and have identified 47,000 species of plants. Out of total 35% are native (endemic) to India has not been reported anywhere in the world. There are 15,000 flowering plants. About 1,336 plant species are considered vulnerable and endangered. The BSI brings out inventory of endangered plants in form of a publication titled 'Red Data Book'

Wildlife of India is a great natural heritage.There are 89,451 animals' species, accounting for 6.5 % of world's fauna. These include 372 mammals, 1,230 bird species, 440 reptiles, 2,456 fish species, 60,000 insect species and 200 amphibians and 500 molluscs (animals having soft bodies with no spine and covered with shells like snails, oysters). In India livestock diversity is high as there are 40 breeds of sheep, 22 of goats and 27 of cattle.

INTEXT QUESTIONS 15.1

1. Name five major types of forest found in India
2. Name four classes of Forest cover given by Forest Survey of India.
3. At which height the alpine forest in the Himalayas are found?
4. Name the famous mangrove tree species found in Sundarbans delta.
5. What is the Annual Rainfall range in dry and wet (moist) deciduous forest?
6. What is the rank of India in flora ranking of the world?
7. How many percent of world's fauna is found is Indias?

15.4 METHODS OF FOREST CONSERVATION IN INDIA

Forest is vital resources for all life forms to exist. It is important to conserve, protect and nurture forests for future generations. There are various methods adopted in India to conserve forest.

Following are various methods and steps to conserve forests in India:

1. Controlling forest fires
2. Afforestation and reforestation
3. Regulated and planned cutting of trees

Controlling forest fires - Forest fire causes destruction and loss of forests and many a limes forest fires become uncontrollable. Forest fires in forests and parks caused major destruction in Australia in December 2019-January 2020. More than 110,000 sq km or 27.2 million acres were burned. Indian forests have not yet been exposed to fires of real significance like other parts of the world. In India there were 37,059 fires in 2018 as detected by MODIS (Moderate Resolution Imaging Spectro- radiometer) sensor. According to forest inventory records about 54% of forests are exposed to occasional fire episodes, 7% to moderately frequent fires and 2% to high incidence while 35% of India's forests are not exposed any real significance. Forest fires are caused either due to natural processes by lightning or friction between trees in summer during high wind speed. It is also caused by human negligence (intentionally or unintentionally) like leaving bonfires unattended or leaving burning cigarettes or beedis on forest floors.

Geographical Information System (GIS) and Satellite based remote sensing technology are important tools which have been effective in better prevention and management of forest fires. Early warning in forest fires prone areas, monitoring fires in real time basis and estimation along with assessment of burn scars are possible with the help of advanced Remote Sensing and GIS technologies. Latest technologies in firefighting along with trained staff, Dome techniques like developing 3 metre wide fire lanes around the periphery of the fires, arrangement to water spray, fire redundant chemicals, help of helicopters are few of the techniques to control forest fires.

Afforestation and reforestation- The areas which witness partial or total clearing of forest areas (deforestation) or due to mining or fire must be reforested. The process can take place naturally by keeping the forest area untouched or fallow so that degraded forests naturally grow back. Afforestation and reforestation can be done artificially by sapling of trees, plants and seeds. New plantations and afforestation programmes not only help in increasing forest cover but also help in making a healthy eco- balance. The tree species used for afforestation should be native and suitable to local geographical conditions. The young trees and plants during their initial growth should be taken care of.

Notes

The Ministry of Environment, Forest and Climate Change (MoEFCC) plays an important role in afforestation plantation schemes with a participatory approach. Joint Forest Management Committees (JFMC) are major implementing agencies after assessing the needs, ecological conditions of the forest area.

Three strategies for conservation and development of forests are adopted.

a. Afforestation through natural/ artificial regeneration

b. Protection

c. Management

Major schemes of forest conservation and development are-

i. National Afforestation Programme (NAP) aims to do afforestation of degraded forest lands. Ecological restoration of degraded forests develops forest resources with local people's participation.

The overall objective of the National Afforestation Programme (NAP) scheme is ecological restoration of degraded forests and to develop the forest resources with peoples' participation, with focus on improvement in livelihoods of the forest-fringe communities, especially the poor. NAP aims to support and accelerate the on-going process of devolving forest conservation, protection, development, and management functions to the Joint Forest Management Committees (JFMCs) at the village level, which are registered societies. The scheme is implemented by a three tier institutional setup through the State Forest Development Agency (SFDA) at the state level, Forest Development Agency (FDA) at the forest division level and JFMCs at village level.

The major components of the scheme include afforestation under Seven plantation models, maintenance of previous years plantations and Ancillary Activities like soil and moisture conservation activities (SMC), fencing, overheads, monitoring and evaluation (M&E), micro-planning, awareness raising, Entry Point Activities (EPA) etc.

ii. National Mission for a Green India Mission (GIM) focuses on improving the quality of forest and increasing forest cover along with cross sectoral activities on a landscape basis.

iii. Forest Fire Prevention and Management Scheme (FFPM)takes measures towards forest fire prevention and management.

Notes

INTEXT QUESTIONS 15.2

1. Identify various methods and steps to conserve forests

   i)…………………...ii)……………..iii)………………

2. Name the major schemes adopted for afforestation in India

   i)…………………...ii)……………..iii)………………

3. Name the three strategies for conservation and development of forests.

   i)…………...ii) ……………iii) ……….

4. Full form of following abbreviations

   (i) SMC

   (ii) JFMC

   (iii) FDA

   (iv) SFDA

15.5 BIODIVERSITY

Biodiversity is a short form of biological diversity. In simple terms biodiversity is the total number of genes, species and ecosystems of a region. Biodiversity broadly means the variability among organisms from all sources including-terrestrial, marine and other aquatic ecosystems and ecological complexes also including the diversity within species, between species and ecosystems. You can find more details on biodiversity is lesson 10. India falls in the category of mega diversity nation.

Plants and animals constitute only a small component of biodiversity. Do you know that invisible micro-organisms constitute a large component of biodiversity? lets know some important term related to biodiverisity.

Genes- The basic biological unit of heredity. Genes of an individual belongingto the same species are similar and genes control the characteristics of particularspecies.

Gene pool- The total amount of genetic material found within a freely interbreeding population at a given time.

Species- A group of very similar genes having some common characteristics or qualitiesand capable of interbreeding.

Habitat- Habitat means the place or type of site where an organism or population naturally occurs.

Biosphere- Biosphere is the part of the earth system comprising all ecosystems and living organisms, in the atmosphere, on land, in inland water bodies or in the oceans and seas. It also includes derived dead organic matter, such as litter, soil organic matter and oceanic detritus etc.

Protected area- A geographically defined area which is designated or regulated and managed to achieve specific objectives.

Indigenous or native species- A species or lower taxon living within its natural range both past and present including the area which it can reach and occupy using its natural dispersal systems.

? DO YOU KNOW?

Taxon- A taxon or taxonomic unit, is a unit of any rank (i,e,. class, Kingdom, order, family, species etc) designating an organism or group of organisms.

Fig. 15.3 Biodiversity

A Significance of Biodiversity

Biodiversity is fundamental to the existence and prosperity of life on the earth. Its importance cannot be underestimated. The varieties of living species are interrelated and interdependent and form an ecosystem. Any disturbance in this very important balance by humans or natural calamities can lead to loss of biodiversity either partially or totally. Human beings are also an important component of biodiversity. Any negligence due to over exploitation of biotic resources by deforestation or wildlife poaching etc leads to imbalance in the system and affects everyone in the chain , even humans. Biodiversity indicates variations of life forms in species, ecosystem and biome. Biodiversity is essential for consistency of climatic features, soil maintenance, ecological balance, pollination of plants, water recycling, recycling nutrients etc. Biodiversity has many direct and indirect uses

Biodiversity increases as we move from the poles towards the equator. India is located between 8°4 North and 37°6' North latitudes and 68°7 East and 97°25 East longitude. Due to this position India has such rich biodiversity.

B Causes of Loss of Biodiversity

Increasing population and changing lifestyle leads to extensive commercial exploitation of the natural resources. The major causes of loss of Biodiversity are invasive species, habitat destruction, global warming and climate change, environmental and genetic pollution, overpopulation and natural calamities. This results in loss of biodiversity. Consequently, it is adversely affecting the ability of nature to continue delivering the goods and services for human existence. The loss of biodiversity affects not only the physical environment but also the social, cultural, religious and spiritual well being of human life. The United Nations has proclaimed the year 2010 as the 'International Year of Biodiversity.

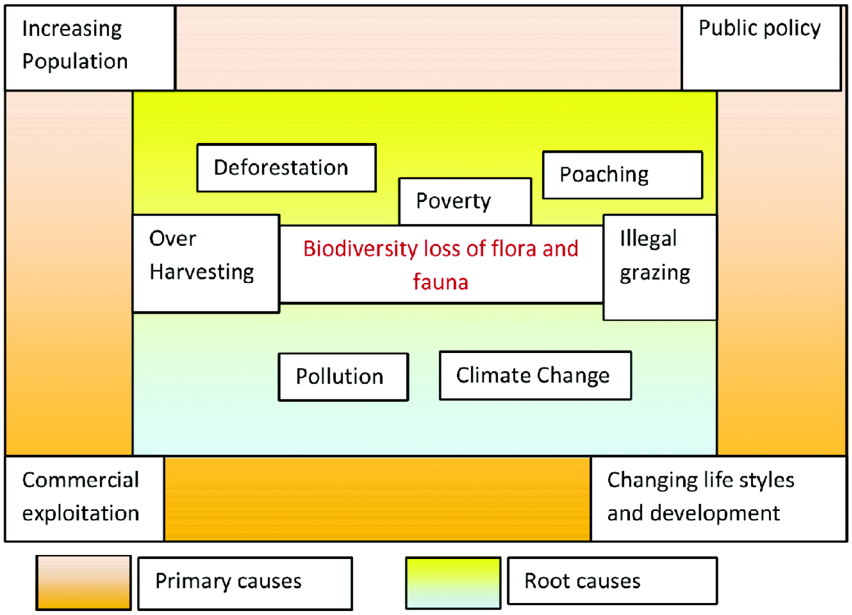


Fig. 15.4 Causes of Biodiversity loss

Notes

C Biodiversity conservation

Biodiversity can be conserved broadly by two methods-

i. **In-situ conservation-** Biodiversity conservation of species takes place within their natural habitat. Large numbers of floral and faunal species are conserved together which is a cost effective and convenient method. The natural ecosystem is maintained and protected without any locational shock to living organisms. For example, national parks, biosphere reserves and wildlife sanctuaries.

ii. **Ex-situ conservation-** In this conservation method breeding and maintenance of endangered species is practised in botanical gardens, zoos, gene banks, nurseries. The species of both plants and animals are bred in enclosed and under the vigil of trained personnel and suitable environments. Later on, species are introduced or reintroduced to natural environments through rehabilitation programmes. For endangered species gene pools are made and genetic techniques are used for preservation of endangered species.

INTEXT QUESTIONS 15.3

1. Define Species diversity
2. Mention the three uses of Biodiversity.
3. Mention Two methods of biodiversity conservation

15.6 BIODIVERSITY HOTSPOTS AND CONSERVATION OF WILDLIFE IN INDIA

The term 'Biodiversity Hotspot' was given by Norman Myers (1988) with the identification of 10 tropical forest hotspots which have witnessed high levels of habitat loss. According to the Critical Ecosystem Partnership Fund (CEPF), by 2016, there are 36 recognized biodiversity hotspots in the world. The international organisation has identified two strict criteria for biodiversity hotspots-

1. The hotspot region at least contains 1,500 species of vascular plants which are found nowhere else on the earth; they are called "endemic" species.
2. The region has lost at least greater or equal to 70 percent of its primary native (indigenous) vegetation.

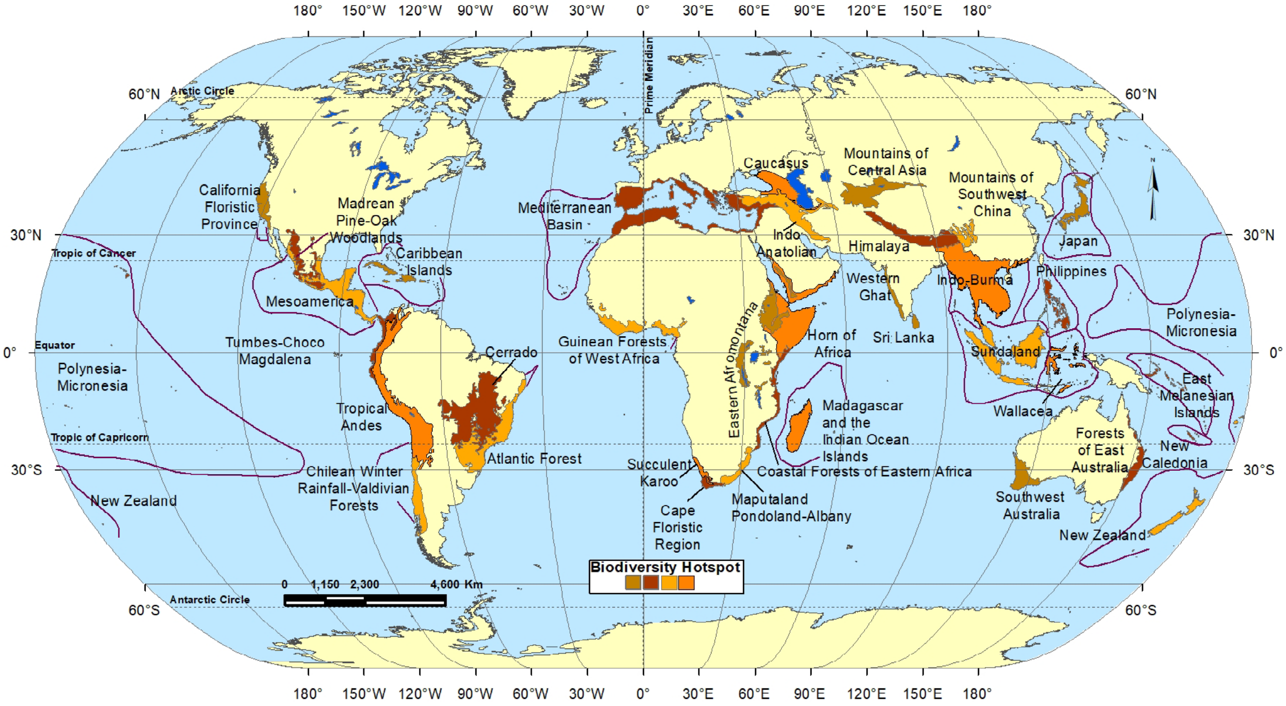


Fig. 15.5 Biodiversity hotspots of the world

A Biodiversity hotspots and various measures adopted by government to preserve biodiversity in India

Having diverse physical features (relief/ terrain, water bodies, soils etc) and climatic conditions (precipitation and temperature), our country has varied ecosystems such as wetlands, forests, grasslands, coastal, marine, desert etc. These ecosystems can sustain and harbour a large variety of species and varied biodiversity and also contribute to human wellbeing. There are 4 major hotspots in India:

Name of the Hotspot	Locations in India
The Himalayas-	Areas of Jammu and Kashmir, Himachal Pradesh, Sikkim, Uttarakhand, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Meghalaya, Tripura and hill regions of West Bengal and Assam come in this zone.
The Western Ghats and Sri Lanka-	Western Ghats include regions in states of Maharashtra, Gujarat Kerala, Karnataka, Tamil Nadu and Goa.
Indo- Burma-	Northeastern India including states of Manipur, Nagaland, Meghalaya, Mizoram and Tripura. It also includes Andaman group of Islands
Sundaland-	Nicobar group of Islands

Important initiatives taken by Indian government for safeguarding these hot spots are:

a. Survey, Inventory generation, taxonomic (classification of living things) validation, threat assessment of floral and faunal resources

b. Designing Biosphere reserves for conservation of representative ecosystems.

c. Establishment of Protected Area Network of National Parks, Wildlife Sanctuaries, Conservation and Community reserves

d. Assessment of forest cover to develop an accurate database for planning and monitoring

e. Species oriented programmes like 'Project Tiger', 'Project Elephant' etc

f. Complemented with ex-situ conservation efforts (meaning conserving biodiversity outside their natural habitats through different techniques like captive breeding, zoos, botanical gardens, aquarium and gene banks etc.

Biological Diversity Act was enacted in 2002 with an aim to conserve biological resources of the country.

B Measures to protect wildlife

In recent decades, human encroachment has posed a threat to India's wildlife. In response to this, the system of National parks, Wildlife sanctuaries and protected areas, first established in 1935, has substantially expanded through wildlife protection Act 1972. Efforts are being made to protect and preserve the biological diversity of our country under various programs. India has preserved vast tracts of natural habitats, birds and plants in its 553 existing wildlife sanctuaries covering an area of 119,776 km2, which accounts for 3.64% of the geographical area of the country (National Wildlife Database, March, 2019). 218 sanctuaries are proposed in Protected Area Network Report covering area of 16,829 km2. There are 101 existing national parks covering an area of 40,564 km2 which accounts for 1.23% of geographical area of the country (National Wildlife Database, March, 2020). 75 additional National Parks are proposed for future in Protected Area Network Report. There are 86 Conservation Reserves in country with an area of 3858.25 km2 accounting for 0.12% of the geographical area. There are 163 existing Community Reserves covering area of 833.34 km2. (National Wildlife Database, March, 2020).

Besides this, there are 35 Botanical Gardens (the oldest and largest is Acharya Jagadish Chandra Bose Indian Botanic Garden in West Bengal), 275 Zoological Parks, Deer Parks, Safari Parks, Aquaria etc. to make people aware conservation of threatened and endangered wildlife species in their respective areas. In India, for the purpose of effective conservation of natural habitat of wildlife, special schemes like Project Tiger 1973 to save the endangered species at the onset 9 reserves were made. There are 53 tiger reserves currently (2022)

accounting for 2.4% of total geographical area of India. Project Elephant have been launched in 1922 and there are 32 elephant reserves in 2010. These are very important as many species are at the brink of extinction. However, none of these efforts will be truly successful unless all Indians recognize their role in conserving biodiversity.

Wildlife Sanctuaries: The main objective of the wildlife sanctuaries is to ensure maintenance of a viable population of wildlife and their desired habitat. There are 553 existing wildlife sanctuaries in India covering an area of 119,776 km2 which accounts for 3.64% of geographical area (National Wildlife Database, March 2019). Another 218 sanctuaries are proposed in the Protected Area Network Report covering an area of 16,829 km2.

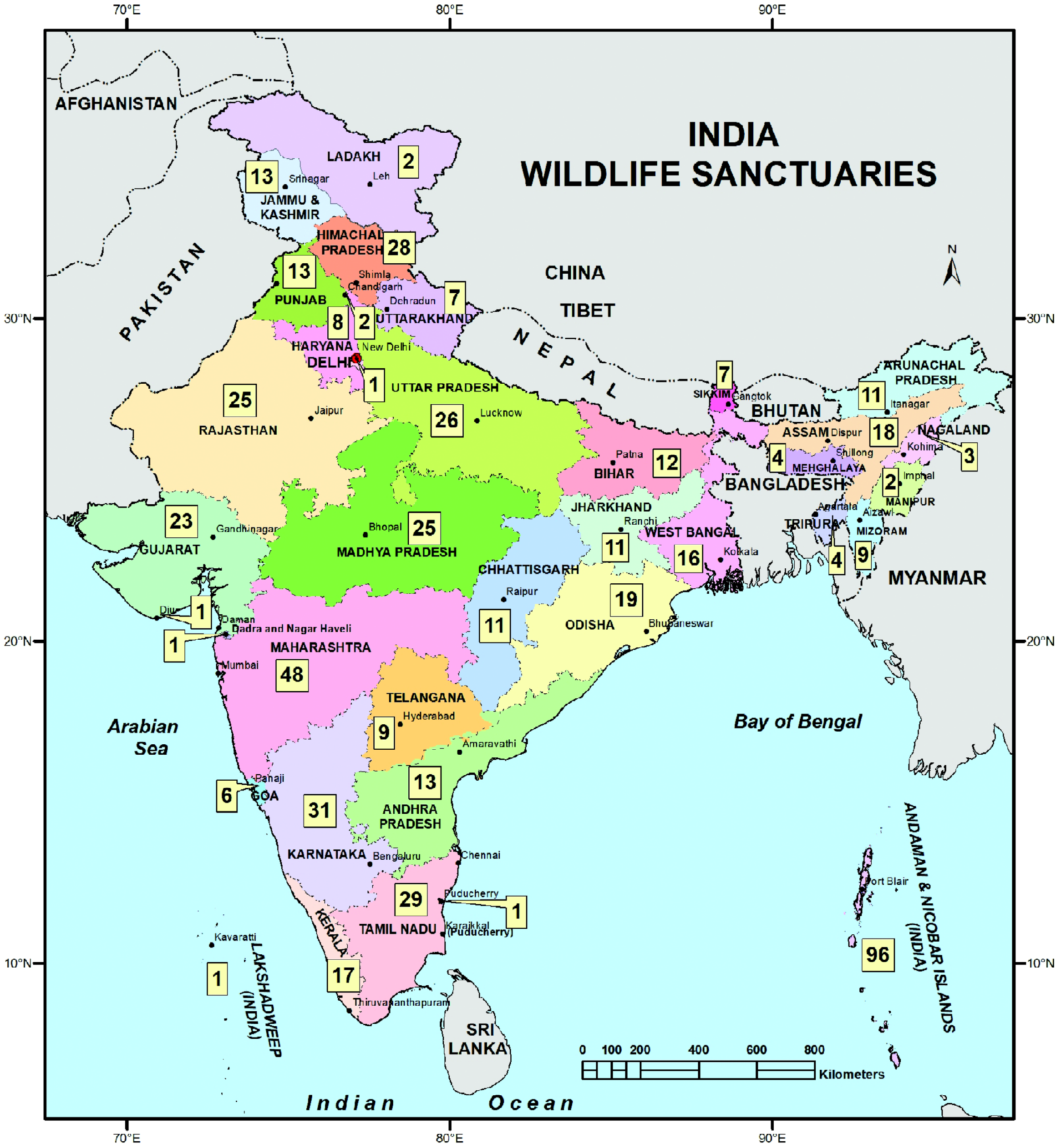


Fig. 15.6 State wise break up of sanctuaries in India

Success story of Panna National Park- Tiger reserve

By year 2009 the Panna national lost all its majestic tigers due to poaching. T1 tigress from Bandhavgarh national park was introduced on 3rd March, 2009. Over the next decade the efforts to restore the past glory of the Panna national park the founder 7 tigers (5 females and 2 males) have mated more than 30 times to produce 80 cubs by 2019.

The Panna National Park is rare success story of very positive initiatives adopted in aspect of wildlife conservation. Still there are challenges remaining along with poaching. Other issues like water scarcity, rocky terrain, rising temperature etc., also puts stress to tiger population.

Ramsar wetland sites

A wetland is an area of land where soil is saturated with moisture either permanently or seasonally. These areas may be partially or completely by shallow pools of water.

Ramsar is a city in Iran and the International treaty for conservation and sustainable use of wetlands was signed in 1971 in this city. So, the wetland sites are named as Ramsar convention sites. The mission of the convention is "the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world". The main aim was to halt worldwide loss of wetlands and build international cooperation, policy making, capacity building and technology transfer.

The convention's focal theme is to maintain the ecological character of wetlands. The list of internationally important wetlands is based on botanical, zoological, ecological, limnological (study of inland water bodies like lakes) or hydrological importance.

The Ramsar Convention is focused on conservation and sustainable utilisation of wetlands and recognizing the fundamental ecological functions of wetlands and their cultural, economic, scientific and recreational value. These are total 75 Ramsar sites (2022) in India.

INTEXT QUESTIONS 15.3

1. How many Hotspots are identified in the world.
2. Name the Hotspots found in India.

   i)...........ii) ....iii)..............iv)............
3. How many biosphere reserves are in India?

15.7 JOINT FOREST MANAGEMENT (JFM)

The state of West Bengal is pioneer in implementation and attaining successful achievements of Joint Forest Management. The model was first introduced in Arabari Reserve Forest Range in west Medinipur district which is commonly Known as 'Arabari Model' introduced in 1971.

The concept of JFM was introduced by the Government of India through the National forest policy of 1988. It involves both the forest departments, and local communities in natural forest management. The village communities are required to form forest protection committees, forest conservation and development societies. Each of the committees has an executive committee to manage its day to day affairs. Under Joint forest management, the Government along with village communities are entrusted with the protection and management of nearby forests. In return to services provided by village communities, they get the benefit of using minor non- timber products. With the involvement of importance of stakeholders, the forest can be conserved in a sustainable manner. Joint Forest Management helps in building a strong setup of state government with participatory approach among local communities. The local community helps in building a strong base at grassroots level of development.

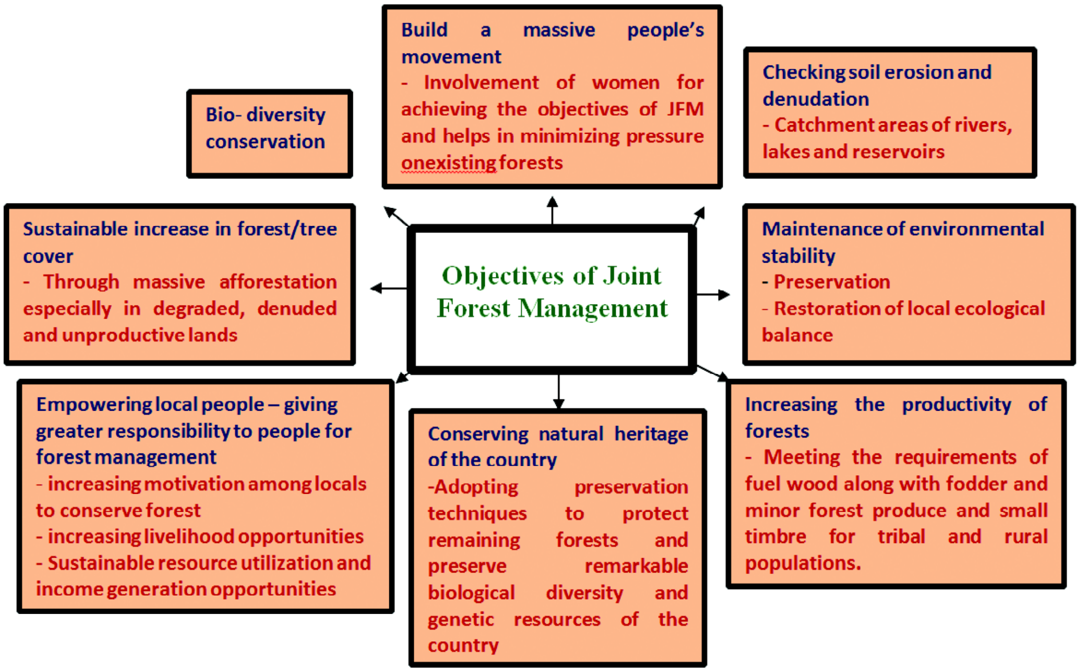


Fig. 15.7 Objectives of Joint Forest Management

a Following are main components of JFM functioning

1. The Joint Forest Management is a generic term for partnership which involves forest management jointly with the state forest department and local communities.

2. The local village committees enter into Memorandum of Understanding (MoU) with the forest department to manage the forest area jointly.

3. The JFM committees have democratic constitution with representation to weaker sections of the society and enhance the role of women in the decision making process. In many JFM committees women are appointed as Chairpersons. In states like Odisha the member secretary is also an elected representative.

4. The nomenclature of JFM is different in some states like Vana SamrakshanaSamities (VSS) in Andhra Pradesh, Van Panchayats in Uttarakhand etc.

5. The resolutions are formed by the state government in accordance with local conditions regarding composition of village institutions. The nature of forest areas taken under JFM with rights and responsibilities of partners and usufructs (it means legal rights are granted to a person or party which grants a temporary right to derive/use income or benefit from forest property which is owned by the government as a natural resource).

6. There are 1,18,213 JFM as of March 2011 in 29 states and 8 UT. Madhya Pradesh has the largest number of 1,228 JFMCs who manage a forest area of 6.69 million hectares.

7. Centrally sponsored schemes like National Afforestation Programme (NAP), other externally aided projects and schemes of Centre and State governments are implemented through the JFM approach.

8. The concept of JFM including livelihood concerns along with conservation management of forests is gaining importance. It includes checking on degradation of forests and provision of employment for the people.

9. The JFM with other institutions plays a vital role. Green India Mission (GIM) proposed to increase the quality of forest cover in 5 million ha and to increase forest cover in another 5 million ha.

b. Strengthening JFM

i. **Legal backup to the JFM committees-** All the state governments register the JFM or village committees under the Societies Registration Act, 1860. All adults of the village should be eligible to become members of the JFM committees.

ii. **Women play an important role in the committees-** Suggested guidelines say that at least 50% of the JFM general body members should be women and at least 33% members of management/ executive committee should be filled by women.

iii. **JFM should be extended in good forest areas-** the programmes aim to cover both the degraded and good areas (crown cover of 40%). The implementation of JFM in good forest shall be done in planned manner on plot basis. The plots

Notes

should be monitored and feedback a success should be assessed and before allowing plot basis use of good degraded forest in the locality should be taken care simultaneously.

iv. **Micro plan in JFM areas-** Flexible guidelines should be evolved for preparation of local need based micro plans for the area in overlapping circles. The micro plans should be prepared by Forest officers and Village Forest Protection Committees while keeping in mind the consumption and livelihood utilising indigenous knowledge along with needs of local communities and as well as attaining them sustainably. The micro planning should be done with due regards to environmental productive and functional potentials of the forests along with carrying capacity of the forest.

v. **Evaluating conservation and biodiversity values of nature-**The micro plan should take into consideration and provide suitable advice for species to be planted in community lands and other Government notified areas outside forest areas including district council areas of North east. The Eco development and infrastructure should have separate entity funding under micro plan through concerned development agencies.

vi. **Identification and recognition of Self-initiated groups-** Community groups in many states like Andhra Pradesh, Gujarat, Odisha, Bihar and Karnataka for regeneration and protection of the forests need to be identified, recognized and registered with JFM.

vii **Conflict resolution-** In order to have harmony and resolve conflicts among all functionaries of JFM the State governments may constitute divisional or state level representative forums including NGOs participation.

viii. **Contribution for regeneration of resources-** To maintain long term sustainability not less than 25% of revenue earned from final harvest should be deposited in village development funds. There should be transparent mechanisms to compute income and sharing benefits among different stakeholders.

ix. **Monitoring and Evaluation-** continuous monitoring of progress and performance taken at Division and State level. The evaluation should be planned after 3 and 5 years at Division and State level respectively.

Some success stories and initiatives of JFM

Gujarat- Gender Equity and Joint Forest Management- Women play an important role in forest management as they do bulk of work for commercial and domestic use, of resources like, fodder, fuel and non-timbre forest produce.

The JFM has been initiated in around 60 villages covering around 3000 hectares through village institutions like Gram Vikas Mandal (GVM) where both men and women can be members, Mahila Vikas Mandal (MVM) where only women are involved.

Odisha- In Odisha there are 2373 Van Samrakshan Samiti (VSS) are protecting 25% of the total degraded forests in the state. There are 5000 Self- Initated Forest Protection Groups (SIFPG's) are also protecting and regenerating forests adjoining their habitation. Kesharpur village in the foothills of Odisha's Nayagarh district villagers guarded the forest from timbre smugglers and stray grazing. Similar efforts are initiated in 28 districts of Odisha. Nowadays local communities have been protecting degraded forests driven by economic needs.

Andhra Pradesh- Behroonguda is a hamlet in Andhra Pradesh. There were 97 families belonging to Naikpod and Gond tribes themselves formad forest protection groups in 1990. In 1998 the state government recognized their efforts an referred them as Vana Samarakshana Samithi (VSS). JFM has allotted 500 hectares of degraded forest of whose cost they have to borne and benefits they derive from it. The residents began to derive usufruct benefits from the forest. TheVSS is widely regarded as being successful. There are now 6580 Vana Samarakshana Samithis (VSS) have been formed. Degraded forest area of 16.58 lakh hectares has been brought under JFM. The Samithis have been successful in upliftment of tribals and bringing them into the mainstream. Like increasing availability of fuel and fodder, reduction in incidences of fire, smuggling illegal grazing, employment for villagers, increase in water table, increase in non timbre products etc.

INTEXT QUESTIONS 15.5

1. The first step towards Joint Forest Management is called as ....model introduced in state of........................ in year...........

2. The concept of JFM was introduced by the Government of India through National forest policy in that year.

3. Which state in India has the largest number of JFMC's and the size of area managed under the JFM scheme.

4. Two example of nomenclature of JFM

   i)..................... ii) ....

5. What are various ways through which strengthening JFM is practised in India?

WHAT YOU HAVE LEARNT

Forest and Biodiversity

- Forest resource
  - Importance and significance
  - Types of natural vegetation
    - Forest cover
      - i) Very dense
      - ii) Moderately dense
      - iii) Open
      - iv) Scrub
      - v) Non forest
  - Diversity - Flora and Fauna
- Biodiversity
  - a) Genetic b) Species c) Ecosystem
  - Significance and use

Causes of Biodiversity Loss

Three major steps taken to conserve biodiversity in India

Biodiversity Hotspots and Wildlife sanctuaries , national parks and biosphere reserves
-identification
-location
- conservation measures

Joint Forest Management
-concept
-objectives
-strengths

Methods of forest conservation
a) Control fire
b) Afforestation and restoration
c) Policies and programmes

Types of Forest
i) Tropical evergreen and semi evergreen
ii) Tropical
iii) Tidal and mangrove
iv) Himalaya and southern montane

TERMINAL QUESTIONS

1. Write a note on the significance of forests.
2. Explain major five types of forest types in India? Describe their distribution and their tree species.
3. Major causes of biodiversity loss, with the help of a diagram.
4. Describe various steps adopted to preserve wildlife in India.

5. Explain vegetation found in southern mountains.
6. Describe various initiatives adopted by the Indian government to safeguard biodiversity hotspots.
7. Name and location of Biodiversity hotspots in India.
8. Discuss measures adopted to protect wildlife in India.
9. Describe the significance and use of Biodiversity with a suitable flow chart.
10. Elaborate on various methods adopted for forest conservation in India.
11. What are Ramsar Wetland sites and how many are located in India?
12. With the help of flow diagrams show objectives of Joint Forest Management.
13. Discuss main components for smooth functioning of Joint Forest Management.
14. Highlight (any five) initiatives taken for strengthening the Joint Forest Management.

ANSWERS TO INTEXT QUESTIONS

15.1

1. Five major types of forest found in India-
   (i) Tropical Evergreen Forests
   (ii) Tropical Deciduous Forests
   (iii) Thorn Forests
   (iv) Tidal Forests and Littoral and Swamp forests
   (v) Himalayan Forests and southern Montane forests
2. Name four classes of Forest cover given by FSI (Forest Survey of India)
   (i) Very dense
   (ii) Moderately Dense Forest
   (iii) Open forest
   (iv) Scrub
3. Alpine Forest found in Himalayas at the height of 3000 to 3800 mts
4. Sundari
5 (i) Dry deciduous forests receive 70 to 100 cm of rainfall annually.
   (ii) Moist deciduous forests receives100 to 200 cm of rainfall annually.

6. India has rich flora ranking 10th in world
7. India is accounting for 6.5 % of world's fauna

15.2

1. (i) Control Forest fires ii) Regulated and planned cutting of trees iii) Proper utilisation of forests products and forests Iv) Protection of forests
2. (i) National Afforestation Programme (NAP) ii) National Mission for a Green India (GIM) iii) Forest Fire Prevention and Management Scheme (FFPM)
3. (i) Afforestation through natural/ artificial regeneration ii) Protection iii) Management
4. (i) SMC- soil and moisture conservation

   (ii) JFMC-, Forest Development Agency

   (iii) FDA- , Forest Development Agency

   (iv) SFDA- State Forest Development Agency

15.3

1. Species diversity covers the full range of species on earth. includes all species, viruses, bacteria, microbes to animals.
2. Three uses of Biodiversity

   (i) Production

   (ii) Consumption

   (iii) Indirect
3. (i) In- situ

   (ii) Ex- situ

15.4

1. 36
2. (i) The Himalayas

   (ii) The Western Ghats and Sri Lanka

   (iii) Indo- Burma

   (iv) Sundaland
3. There are 553 existing wildlife sanctuaries in 2019, India covering an area of 119,776 km2 which accounts for 3.64% of geographical area.

Notes

4. 15
5. (i) The hotspot region at least contains 1,500 species of vascular plants which are found nowhere else on the earth; they are called "endemic" species.

   (ii) The region has lost at least greater or equal to 70 percent of its primary native (indigenous) vegetation.

15.5

1. Ramsar is a city in Iran and the International treaty for conservation and sustainable use of wetlands was signed in 1971 in this city.
2. 41
3. Sundarbans wetland and 4320 sq km

15.6

1. The first step towards Joint Forest Management is called as Arabarimodel introduced in state of West Bengal in year 1971
2. 1988
3. Madhya Pradesh has the largest number of 1,228 JFMC's and forest area 6.69 million hectares.
4. (i) Vana Samrakshana Samithi (VSS)

   (ii) Van Panchayats
5. (i) Legal backup to the JFM committees

   (ii) Women plays an important role in the committees

   (iii) JFM should be extended in good forest areas

   (iv) Micro plan in JFM areas

   (v) Evaluating conservation and biodiversity values of nature

   (vi) Identification and recognition of Self- initiated groups.

16

WATER RESOURCES

Water is one of the basic resources for human beings as well as all other life forms on earth. Water is so important for life that we cannot imagine life without it. The evolution of life itself took place in the water. In the evolution of all kinds of life, water has played an important role. The amount of water found in living beings is 65 percent and 65 to 99 percent in plants. This clearly shows the need and utility of water. Water, which is a precious gift of nature , has several uses. Water is very essential for development. Although it is available in abundance covering 3/4 of the earth, yet it is a scarce resource; and the fact is that only 3 % is potable. Hence its utilisation and conservation is the most challenging task for mankind. The demand for water continues to rise whereas the supply and availability of water resources is limited as far as human use is concerned. Thus, an efficient planning and implementation programme of water resource appraisal, development, conservation, and management is required.

From the point of view of availability and suitability, the potable water is limited in India. Moreover, it has highly uneven geographical distribution. Another disturbing issue is day by day deteriorating quality of water. It is a matter of great concern for all of us. Besides coordinating the demand and supply of the water, there is a need to keep the balance among different sources of water along with the balance among different uses of water. Hence conservation of water resources is an essential requirement.

OUTCOMES

After studying this lesson, learner:

- states the significance of water resources;
- describes the different sources of water and its utilisation pattern;
- explains the uneven distribution of water;
- asseses the issues related to water resources and suggest solutions and

- analyses methods of Water Resource conservation and Management with special reference to traditional methods.

16.1 WATER RESOURCES: SIGNIFICANCE FOR LIFE

Water is the most valuable resource of nature. This is a renewable and inexhaustible resource but is in trouble these days. Demand for water has been increasing continuously and its supply decreasing. If we look at the water resources of India in the global context, India has 4 percent water whereas she is housing 16 percent of the world's population. It means the per capita availability of water is quite low in our country. One-eighth area of the country is flood prone and one-sixth area is under the grip of drought. Nature of the monsoon is mostly responsible for uneven distribution of water. Food grains and other agricultural products are required in large quantities for the growing population. For this reason, the use of water for irrigation of crops has been increasing. India ranks first in the world in terms of irrigated area. The demand for water has increased in the cities due to rapid urbanisation, industrialization, and modernization. In addition, the demand for water has been increasing for sewerage and for removing all kinds of wastes.

16.2 SOURCES OF WATER

There are four main sources of water:

A. Surface water

B. Underground water

C. Atmospheric water

D. Oceanic water.

In our daily life we use only surface water and underground water.

A. Surface water

The main source of surface water is precipitation. About 20 percent of the precipitation evaporates and becomes atmospheric water. A part of the running water goes underground. The large part of surface water is found in rivers, rivulets, ponds, and lakes. Remaining water flows into the seas, oceans. Water found on the surface is called surface water. About two - third of the total surface water flows into three major rivers of the country - Indus, Ganges and Brahmaputra.

The water storage capacity of reservoirs constructed in India so far is about 17400 billion cubic metres. At the time of independence, the water storage capacity was only 180 billion cubic metres. Hence water storage capacity has increased about ten times. The storage capacity

Notes

of usable water in the Ganges basin is the maximum. Despite maximum annual flow, the storage capacity of usable water is the least in the Brahmaputra basin. The storage capacity in Godavari, Krishna, Mahanadi and Indus is sufficient. Annual water flow in the three major rivers of India - Indus, Ganga and Brahmaputra are very high. Hence water storage capacity of these rivers can be increased.

Table 16.1 INDIA: Distribution of surface and underground water according to river basins (Figures in billion Cubic metre)

River Basin	Catchment Area (km^3)	Avg. monsoon runoff (km^3)	Avg. annual SW potential (km^3)	Estimated utilisable SW (km^3)	Estimated replenishable GW (km^3)	Static GW reserve (km^3)	Predominant Aquifers
Indus	321289	58.60	73.31	46.00	26.49	1338.20	Cr
Ganga	861452	401.30	525.02	250.00	170.99	7834.10	Al, Cr
Brahmaputra, Barak, and others	236136	477.50	585.60	24.00	35.07	1018.50	Al, Cr
Godavari	312812	107.10	110.54	76.30	40.65	59.40	DT, Cr,
Krishna	258948	61.00	78.12	58.00	26.41	36.00	DT, Cr, St
Cauvery	81155	18.90	21.36	19.00	12.30	42.40	Cr, St
Subernarekha	29200	6.20	12.37	6.81	1.82	11.10	Cr, Al
Brahamani and Baitarni	39033	15.30	28.48	18.30	4.05	41.30	Cr, St
Mahanadi	141589	16.00	66.88	49.99	16.46	66.00	Cr, St
Pennar	55213	60.20	6.32	6.86	4.93	119.70	Cr
Mahi	34842	32.60	11.02	3.10	4.20	43.40	Al
Sabarmati	21674	9.70	3.81	1.93	3.00	10.80	Al
Narmada	98796	3.40	45.64	34.50	10.83	28.20	DT, Al
Tapi	65145	10.70	14.88	14.50	8.27	12.60	Al
West flowing rivers from Tapi to Tadri	52900	13.60	87.41	11.94	8.70	113.20	DT
West flowing rivers from Tadri to Kanyakumari	56200	36.90	113.53	24.27	9.00	18.40	Cr
East flowing rivers between Mahanadi and Pennar	—	16.20	22.52	13.11	9.00	7.50	Cr
East flowing rivers between Pennar and Kanyakumari	100100	80.30	16.46	16.73	9.20	11.20	Cr
West flowing rivers of Kutch, Saurashtra including Luni	321900	97.80	15.10	14.98	11.23	—	Cr, St
Area of inland drainage in Rajasthan desert	60000	—	—	—	—	—	Sand, Al, St
Minor river basins draining into Bangladesh and Myanmar	36300	24.80	31.00	—	18.80	—	Al, St
Total	3184684	1548.10	1869.37	690.32	431.40	10812.00	

Source: Basin wise distribution of surface and groundwater resources in India (source: Central Water Commission and Central Ground Water Board)

Fig. 16.1 : India Basin wise Water Resource

B. Underground water

Rain water percolates into the earth's surface and becomes underground water. The process of percolation also takes place from the surface water. Large amount of water gets collected under the Earth's surface by these two methods. This is called underground water.

According to the Central Underground Water Board, the annual replenishable underground water resource in India is 433 billion cubic metres. Out of this about 399 billion cubic metre water is available for various uses.

The distribution of underground water is not the same everywhere. Availability of underground water depends upon the amount of rainfall, nature of rainfall, nature of land and its gradient. In the areas of high rainfall where the land is almost flat and has porous rocks, the water easily percolates and reaches the aquifers. Therefore, underground water is available in plenty at shallow depths in these areas. In the areas like Rajasthan where the land is flat and has porous sandy soil, the underground water is less in amount and is available at greater depths due to lack of rainfall. In the North-Eastern regions of the country, in spite of adequate rainfall, underground water is available in less quantity at greater depths. It is because the land is sloppy and the conditions are not suitable for percolation of water. There are large reserves of underground water in the plains of Ganga - Brahmaputra and in coastal plains. The availability of underground water is less in peninsular plateau, Himalayan region and desert areas.

Underground water is used on a large scale in the areas where the rainfall is comparatively less. The use of groundwater is more in Punjab, Haryana, Rajasthan, Tamil Nadu, Gujarat and Uttar Pradesh. Andhra Pradesh, Madhya Pradesh, Maharashtra, Karnataka and Chhattisgarh are such states where in spite of rainfall, the use of underground water is less. There is a dire need to develop underground water resources in these states.

16.3 WATER BUDGET

Water Budget means the balance between the available water in the country and the water under use. There is a great variation in the availability of water resources in India. The availability of water also varies according to the season. Water is available in sufficient quantities during the rainy season. As the dry season sets in, there is a shortage of water. Likewise water is available plentily in areas having flat surface, porous soil in comparison to the areas having sloped land and non-porous soil. The use or demand on water resources is increasing day by day with the increase of population. The reserves of our surface and underground water are about 23840 billion cubic metres. Out of this only 10860 billion cubic metre water is required for use. The unit of measurement of the amount of water is cubic metre and hectare metre.

In simple terms, Water budget means the rate of change in water stored in a region. For example, a watershed is balanced by the rate at which water flows in and out of the region. After thorough understanding of water budgets and underlying hydrologic processes, a foundation for effective water-resource and environmental planning, conservation and management could be formulated. The Observed changes in water budgets of an area over time thus can be used to assess the effects of changes in the climate and as a result of human activities on water resources. Comparison of water budgets from different areas helps in assessing the factors such as geology, soils, vegetation, and land use on the hydrologic cycle.

The natural hydrological cycle is affected in many ways by human activities. Modifications carried out on the land to accommodate large scale agriculture, such as installation of drainage and irrigation systems, many a times alter infiltration, runoff, evaporation, and evapotranspiration rates. Similarly, Buildings, roads, and parking lots in urban areas tend to increase runoff and thus decrease infiltration. Dams reduce flooding in many regions. Water budgets thus provide a basis for assessing how a natural or human-induced change in one part of the hydrologic cycle may affect various other aspects of this cycle.

INTEXT QUESTIONS 16.1

1. What is the ranking of India in the World in terms of irrigated area
2. The surface water storage capacity of which river basin is maximum in India?
3. Name 5 states of India where underground water is used on a large scale.

16.4 UTILISATION PATTERN

Population in India has been increasing rapidly. It has increased about three times since independence. Due to this increase in population, the demand for water has increased in all the spheres for eg. for domestic use, irrigation and industries. On the other hand, per capita annual availability of water has been decreasing over the years. In 1951 per capita annual availability of water was 5177 cubic metre per person which has decreased to 1829 cubic metre per person annually in 2001. In the coming years by 2025 per capita availability of water is expected to become 1342 cubic metres annually. It is to be noted that the water crisis arises when the per capita availability of water falls below 1000 cubic metres annually. Today many countries are facing the water crisis and have to import water to sustain.

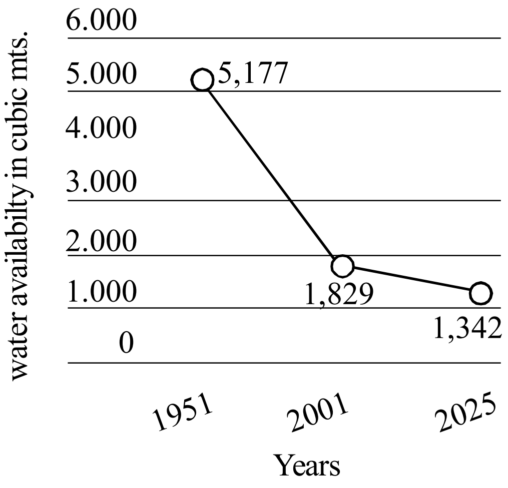


Fig. 16.2 : Water Availability in India

Notes

Water is used for many direct and indirect purposes. Direct purposes include mostly domestic i.e. bathing, drinking, cooking and irrigation while examples of indirect purposes are in processing wood to make paper and also in producing steel for automobiles. The major bulk of the world's water use is for agriculture, industry, and electricity. Even one cannot imagine fishing, forestry and water sports without huge amounts of water resources. In this way, water is essential for all kinds of developmental work. It is essential in all spheres of life. Due to rapid growth of urban population, the demand for water in urban areas has increased tremendously.

The most common water uses include:

- Domestic (drinking and Household) Needs;
- Recreation (Sports activities such as River Rafting, Kayaking etc);
- Industry and Commerce;
- Agriculture (Irrigation);
- Hygiene and Public Health;
- Hydroelectricity Generation (Energy)

We humans require fresh water. Only 2.5% of total water on the Earth is freshwater, and over two-thirds of this is frozen in the glaciers and polar ice caps. The Water demand already exceeds its supply in many parts of the world, and many more areas are expected to experience this imbalance in the very near future. It is estimated that 70% of world-wide water use is for irrigation purposes in agriculture. Climate change will have significant impacts on the water resources. Due to the ever increasing human population the demand for water is growing day by day and many of the world's major aquifers are getting depleted. Pollutants from industries threaten the water quality, but the most widespread, especially in the less developed countries, is the discharge of raw sewage into natural waters.

Table 16.2 India: Changing pattern of use of water 1990-2050
(Figures in billion cubic metere)

Use	1990	2000	2010*	2025*	2050*
Domestic	25	33	42	52	60
Irrigation	460	536	653	770	800
Industry	15	30	79	120	130
Energy	19	27	44	71	120
Others	30	33	35	37	40
Total	549	659	853	1050	1150

*Estimated

India is an agricultural country. Hence plenty of water is needed for irrigation. 536 billion cubic metre water was used for irrigation in the year 2000. It is 81 percent of the total water used. The remaining percentage of water was used for domestic, industrial and other purposes.

There has been a rapid increase in the irrigated area in India since independence. Total irrigated areas in 1999-2000 was 8.47 crore hectare. The maximum capacity of the use of water for irrigation in India is 11.35 crore hectare metre. But about three-fourth water of this capacity is being used. The demand for irrigation in India has been increasing continuously.

The reasons for the increasing demand of irrigation are as follow:

1. Regional and seasonal variations in the distribution of rainfall.
2. Wide and uncertain gaps in rainfall season.
3. Growing demand for water for commercial crops.
4. Changing cropping pattern.

MEANS OF IRRIGATION

There are three main means of irrigation in India:

A Wells and Tubewells;

B Canals; and

C Tanks.

TUBEWELL

WELL

TANK

CANAL

Fig. 16.3 : Means of Irrigattion

Notes

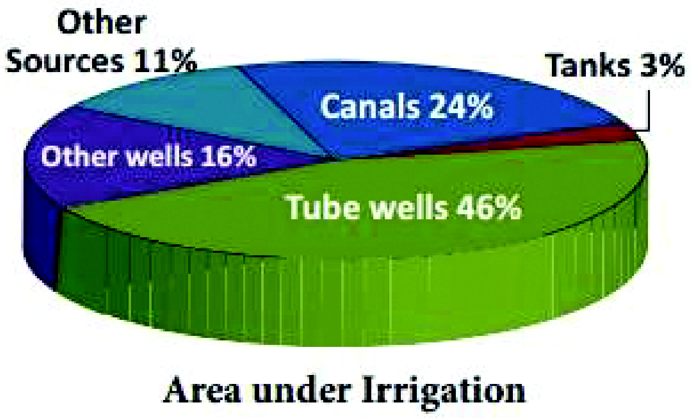


Fig. 16.4 : Area under Irrigation

A. Wells And Tube-Wells

Irrigation by wells is an old practice in India. It has increased tremendously with the use of diesel and electric pumping sets. Irrigated area by wells and Tubewells in 1950- 51 was only 59 lakh hectares which has increased to 30 million hectares in 1997- 98. During this period total irrigated area has increased from 30 percent to 57 percent. From 2001- 02 to 2014-15 there is 20% increase in net irrigation, due to extensive extraction of groundwater. In the said period i.e. 2001-02, nearly 41% of Net irrigated area got water from Tube Wells whereas this increased to 46% in 2014-15. but Irrigation declined from 21% to 16% only. Uttar Pradesh has the largest area under Well irrigation followed by Rajasthan, Madhya Pradesh, Punjab, Gujarat, Maharashtra and Bihar. There are large reserves of underground water in the alluvial plains of north India. Digging and constructing wells and tubewells is easy and the cost of their construction is also comparatively less. Therefore, irrigation by wells and tubewells is popular among farmers. In states like Gujarat, Goa, Rajasthan and Maharashtra, only about 60 percent irrigation is carried on by wells and tubewells.

B. Canals

Canals were the main means of irrigation upto 1960. Canals contributed about 40 percent in the total irrigated area of the country. In 1996-97 it came down to about 31 percent. About 1.74 crore hectare area was irrigated by canals in 1996- 97. Half of this area (52.5 percent) is limited to the states of North India. Haryana, Odisha, Karnataka, West Bengal, Andhra Pradesh and Punjab are worth mentioning for canal irrigation. Jammu-Kashmir, Mizoram, Assam and Tripura are such states which greatly depend upon canal irrigation because there is lack of other means of irrigation in these states. Mizoram which has the least irrigated area is completely dependent upon canals for irrigation. Canal irrigation declined from 27% in 2001-02 to 24% in 2014-15.

C. Tanks

The contribution of tanks in irrigation has reduced. About 3 percent of the irrigated area is irrigated by tanks. Irrigation by tanks is popular in the peninsular plateau area. Tamil Nadu is the leading state in irrigation by tanks. About 22 percent of the area is irrigated by tanks here. In Odisha, Maharashtra, Karnataka, Kerala and West Bengal tank irrigation is prevalent.

INTEXT QUESTIONS 16.2

1. What are the various means of irrigation in India?
2. Name the states where irrigation is done mainly by tanks?
3. Give reasons for the increase in demand for irrigation.

16.5 RAIN WATER HARVESTING

Rain water harvesting generally means collection of rainwater where it falls. Where there is shortage of water, groundwater can be recharged by harvesting rainwater. In this process, water is made to go underground after collecting rain water locally, without polluting the same.

Why do we need Rain water harvesting?

Three main reasons are responsible for this:

1. Scarcity of surface water
2. Growing dependence on underground water.
3. Increasing urbanisation.

There can be two Scenarios of Rain water harvesting:

A. Urban Scenario

Total amount of rain water recovered in an area is called 'rain water reserve'. Effective management of rain water reserves is called 'potential water harvesting'. Think for a while the area of the roof of your house is 100 square metres and the 'average rainfall' of this area is 60 cms. Suppose the water on the roof has neither flowed, percolated nor evaporated then there will be 60 cms, high water on the roof.

Volume of water = Area of the roof X Amount of annual rainfall = 100 x 60 cms = 100 x .6 = 60 cubic metres.

Notes

In other words, a family can collect 60,000 litres of water in a year. All water related needs of this family can be met with this. On an average a person needs 10 litres of water for drinking daily. If your family consists of 6 members, then you need 6x10x365 = 21900 litres of water. Remaining (60,000 - 21,900) = 38,100 litre water can be used in dry weather when there is a scarcity of water.

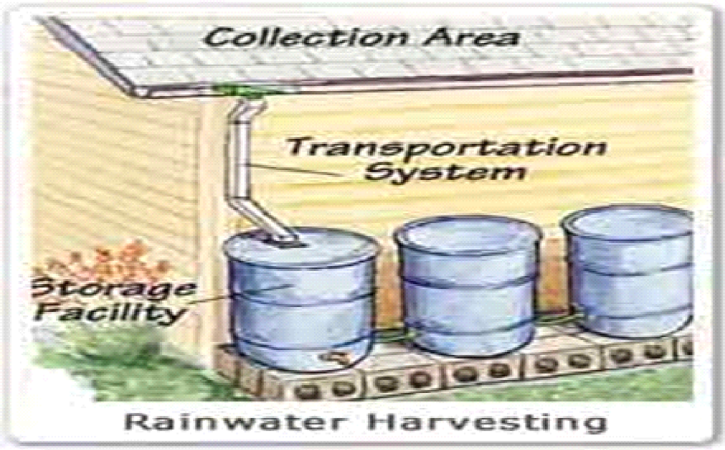


Fig. 16.5: Rainwater Harvesting in Urban area

B. Rural Scenario

The tradition of rainwater harvesting is very old in India. But the utility of water harvesting has never been felt so much as it is today. Even today the people living in the areas of water scarcity try to do their domestic work by adopting old methods. Deepening and dredging of wells, tanks and ponds are included in these methods. Water harvesting in the small channels (locally known as bawli) is an important traditional method in the areas of water scarcity. Now we can be in a better and secure situation by adopting a new technique of water harvesting. Think for a while. If the people living in 5,87,000 villages in India, engage themselves in harvesting rainwater of their 2000 lakh hectare area, there will be a lot of water available for use. On an average a village comes under the radius of 37,500 lakh cubic metre rain water reserve. By this calculation we come to know that there is great potential for rainwater harvesting.

Fig. 16.6 : A Traditional Method of Rainwater Harvesting

METHODS OF RAINWATER HARVESTING

We can adopt different methods for rainwater harvesting according to need, available facilities and environmental conditions. The following methods are worth mentioning-

1. Construction of potholes - We can harvest water in small ditches constructed in those areas where there is not much underground water. These ditches may be constructed 1-2 metres wide and 2-3 metres deep. Their shape could be anything. These ditches are filled with rubbles and sand. Rainwater can easily percolate through these.

2. Construction of trenches - In the lower regions where porous rocks are found after making trenches of 0.5 to 1-metre width, 1 to 1.5-metre depth and 10 to 15-metre length, these are filled with rubbles. These trenches should be made parallel to the slope of the land.

3. Use of wells - The wells which have become dry and are not being used at present can be used for water harvesting.

4. Handpump - Stored rainwater can be made underground with the help of a filter by running handpumps in the areas of lack of underground water.

Case Study of Rainwater Harvesting

Dudhatoli Lok Vikas Sansthan

Ufrakhal, Pauri Garhwal, Uttarakhand

Ufrakhal village, located in the midst of Chamoli and Almora region, was once considered one of the most backward areas in India. Today, it is completely transformed. The person responsible for this change is Sh. Sachidanand Bharti. He started mobilising women to conserve forests. Then, his task became simple. The villagers began to understand that the conservation of water, land and forest can be done in an integrated manner.

Initial setbacks like the dying of the saplings instigated Bharti to find a solution. After discussions with the villagers, it was decided to dig small pits near the newly planted saplings to collect enough water during monsoon. The idea clicked. Today, the trees of Baas, Kaafal, Amaat, Chir, and Awala amongst many other species are the most precious jewels of this forest. Next, he encouraged the villagers to dig 1,500 small pits (Jal Tarais) in the forests of Gaadkhark. The impact was immediate and evidently inspiring. Today, a number of small nallahs (drains) have become perennial, which culminate into a big nallah known as Gaadganga.

INTEXT QUESTIONS 16.3

1. Why do we need to harvest rainwater?

2. Name any two methods of rain water harvesting.

3. How is water being conserved and channels recharged in Ufrakhal, Uttarakhand?

16.6 ISSUES OF WATER RESOURCES

There are many issues related to water resources. The list is exhaustive. There is scarcity, pollution, depletion of water. We can list them as follows:

- Intense urbanisation leads to increasing demand for water,
- Pollutants in water due to release of untreated industrial water and urban sewage to water bodies
- Tremendous demand for water for drinking and economic and social development.
- Water stress and scarcity in many regions of the planet due to alterations in availability and ever increasing demand.
- Problems of stress/pressure and scarcity due to global changes with extreme hydrological events
- Problems caused by the lack of articulation and lack of consistent actions of governability of water resources as well as environmental sustainability.

16.7 NATIONAL WATER POLICY

The main Objective of National Water Policy is to take cognizance of the existing situation of country's water resource, and to propose a framework for creation of a system of laws and institutions and further for a plan of action with a unified national perspective.

Water is a national valuable reserve. It is essential for the Government to evolve policy for the development and management of water resources so that surface and underground water is not only properly used but also conserved for the future. Nature of rainfall has also compelled us to think in this direction. 'National Water Policy' was formulated and accepted in September 1987. It was revised in 2002 and presented as 'National Water Policy' 2002 and again updated in 2012 as problems arose in the previous policy during the course of time.

Water is an important constituent of the ecosystem. It should be considered essential for all kinds of life. It should be developed, conserved and managed in a planned manner. It is essential to think about its social and economic aspects of water as large areas of the country

suffer due to drought and floods every year. It causes not only the loss of property and human life but the wheel of development is also stopped. The problems of floods and drought are not limited to the boundaries of a particular state. This requires thinking at the national level. Several problems arise in planning and management of water resources. More exploitation of underground water in many areas of the country have posed serious challenges such as dried up aquifers as well as lowering of water table. The demand of water is on increase for domestic use, industries, energy production etc. Water resources are already scarce, and with ever increasing demand by the growing population there shall be a worrisome future of water. Quality of water is also an important aspect. Pollution of surface and underground water has been increasing. Main sources of water pollution due to human activities include domestic wastewater, industrial effluents and chemicals used in agriculture. Sometimes water pollution is also caused by natural factors. Erosion, landslides, decomposition of plants and animals are the main natural sources of water pollution. Three fourths of the total surface water in our country is polluted.

IMPLEMENTATION OF NATIONAL WATER POLICY

National Water Board should prepare a plan of action, based on the National Water Policy, as approved by the National Water Resources Council, to regularly monitor its effective implementation. The State Water Policies may need to be drafted/revised in accordance with this policy keeping in mind the basic concerns and principles in a unified national perspective.

Watershed Development Programme

Watershed is defined as an area where the runoff resulting from rainfall is collected and drained out through a common point. Watersheds are composed of a number of streams and creeks that drain into progressively larger streams to eventually form a river. Each of the streams or creeks have their own watersheds, or sub-basins, that flow from higher elevations to lower elevations. The adjacent watersheds are separated by ridges which are called water divides. Within a watershed, water may come from various directions, but it drains out at a single point. Therefore, it is easier to manage water, soil and forest and other related resources within small watersheds by checking water at outlet points. By growing forests in the upper reaches of the watershed, the water flow through streams slows down, groundwater gets recharged and soil erosion gets reduced. The drained out water at the outlet point can be checked easily. Therefore, small watersheds are the ideal units to manage the natural resources like land, soil, water, forest etc.

The Watershed Development Programme was originally initiated by the National Wasteland Development Board, Ministry of Environment and Forest. Now the programme is placed under the Department of Land Resources under the Ministry of Rural Development. The Department of Land Resources is implementing the Integrated Watershed Development Programme (IWMP) from 2009-10 with an objective to cover 55 million hectares of rain fed land by 2027.

Benefits of Watershed Development Programme:

- Water storage, flood control, checking sedimentation
- Erosion control and prevention of soil
- Recharging groundwater to provide regular water supply
- Minimising over-exploitation of resources
- Increase in the agricultural production and productivity
- Decrease in deforestation
- Wildlife preservation
- Pollution control

The success of Watershed Development Programme is possible by:

a. More scientific thinking;

b. perfect techniques;

c. Participation of local population;

d. coordination among various departmental agencies, and

e. an independent ministry to follow up.

National River Linking Programme

The Inter-Linking of Rivers (ILR) programme is aimed at linking water surplus river basins with water deficit river basins so that the excess water from surplus regions could be diverted to deficient regions. The idea behind the interlinking of rivers is to reduce flood and drought havocs in water surplus and water deficit areas respectively. Thirty-seven rivers are identified to be interlinked by a network of about 3000 storage dams.

Benefits of River Linking Programme

- The irrigation of about 250 lakh hectare additional agricultural area is possible by surface water after the success of this programme.
- Underground water will be available to irrigate additional agricultural areas of about 100 lakh hectares.
- Additional hydro-electricity of about 340 lakh kilowatt will be generated.
- Besides these benefits, many other benefits like flood control, water transport, water supply, fishing, removal of acidity from the soil and control on water pollution will also be achieved.

Challenges in River Interlinking

- **Project feasibility:** The estimated cost of the Project is very high which requires huge structure and great engineering capacity.
- **Environmental impact:** The wildlife, flora and fauna of the river systems would be affected because of large scale displacements and modifications.
- **Impact on society:** The displacement of people for building of dams and reservoirs would create agony among local people.
- **Inter-state disputes:** The dispute among states coming under particular projects may arise for sharing of water and other resources.

16.8 METHODS OF WATER CONSERVATION

If we do not conserve water today, future generations may have difficulty surviving due to scarcity of water. The participation of an individual, society and the Govt. is essential for water conservation.

The following methods can be adopted for water conservation -

1. Dams and reservoirs should be constructed on rivers so that river water does not go waste into the seas and oceans.
2. The water of rivers should be saved from pollution by urban waste at all costs.
3. Mass awakening should be around for water conservation.
4. Solicit active participation of the people in all the activities related to water conservation and efficient management.
5. Potable water should not be used for gardening, washing of vehicles and cleaning of households.
6. Broken pipelines of water should immediately be repaired.
7. Every drop of water is precious, this should be popularised among the masses.
8. Such crops should not be grown in rain fed areas which require more water.
9. There should be stress on afforestation.

A case study: efforts of tarun bharat sangh towards water conservation

Tarun Bharat Sangh was established in 1985 under the guidance of Shri Rajendra Singh. It started in Hamirpur village of Thanagazi Tehsil in Alwar district of Rajasthan. The residents of

Thanagazi area under the guidance of Tarun Bharat Sangh(NGO) achieved such a miracle which could not be achieved by Central Water Authority while searching for the Sarswati in Western Rajasthan and Bhabha Atomic Research Centre together. Arvari river was reborn with the efforts of this organisation which took 15 years. Previously the river was dry and barren. There are two branches of Arvari river. The total length of these is 45 kilometres. Its watershed area is spread in 503 square kms. Parts of Jaipur, Dausa and Alwar districts are included in this. Previously agriculture was practised here. There were no means of irrigation. Agriculture used to be done only on 10 percent of the land. Agriculture was entirely dependent upon rain. There was one cropped agriculture. To remove the water scarcity in the area, the NGO-Tarun Bharat Sangh with the help of villagers cleaned and deepened the tanks and ponds. Besides this, they also vowed to construct ponds on the sloppy parts of the hilly region. A village was chosen for this work in 1985-86. The results were very encouraging. Many other villagers followed the same process by making ponds constructed in their areas. 'Save water' and 'JoharAndolan' were started in 1996. More than 3500 ponds have so far been constructed in this area. The villagers themselves have constructed more than 70 ponds. Water level of underground aquifers has risen after construction of these ponds. Water is available throughout the year in wells, tanks, ponds and rivers. Agricultural output has also improved. There is more Greenery. Even the animals are healthier, cows and buffaloes are helping in the rise of dairying as a supplementary occupation,

The standard of living of the people has improved. The families below poverty line are also able to earn 40-50 thousand rupees per annum. Migration of people from villages to cities has stopped. Even migrated families have now started coming back to their villages. The residents of 70 villages in Arvari river basin have constituted a unique 'parliament' of 150 members. This 'parliament' has been named as 'Arvari Sansad' after the name of the Arvari river. The members of 'Arvari Sansad' took oath on the banks of the river in Hamirpur on 26th January 1999. The constitution of Arvari Sansad came into effect from this day. This is such a sansad which not only frames the rules and laws but follows them also. All residents of the area follow these rules and laws strictly and also get them followed by others. Arvari sansad has framed some rules and laws keeping the needs of the people, ecological balance and land in mind.

The following are worth mentoring among them:-

1. Ban on growing crops such as sugarcane, rice and chillies which require more water.
2. No one will use the river water for agriculture after Holi and before the end of the rainy season.
3. No industrial unit will be established in the watershed area.
4. Recommended growing of millets, Jowar-Bajra and Maize.

5. Allowed to grow vegetables in the lower parts of the river.

6. Ban on hunting and cutting of green trees.

7. No person with an axe will enter into the recently developed 'Bhairon Dev Manas' sanctuary.

8. The whole region has been declared as an area of biodiversity

9. Ban on sending food grains and vegetables outside the region

10. Ban on grazing of animals by the people living outside the watershed area.

Today Arvari river has become very useful for the residents of the area. The people of the area worship this river also. Fairs and festivals are celebrated. Arvari Sansad has established 'Arvari temple', 'Arvari treasury' and 'ArvariSectariate'. Such programmes are being carried on in other areas also. In this connection very encouraging programmes are going on in Gujarat, Madhya Pradesh and Chhattisgarh.

INTEXT QUESTIONS 16.4

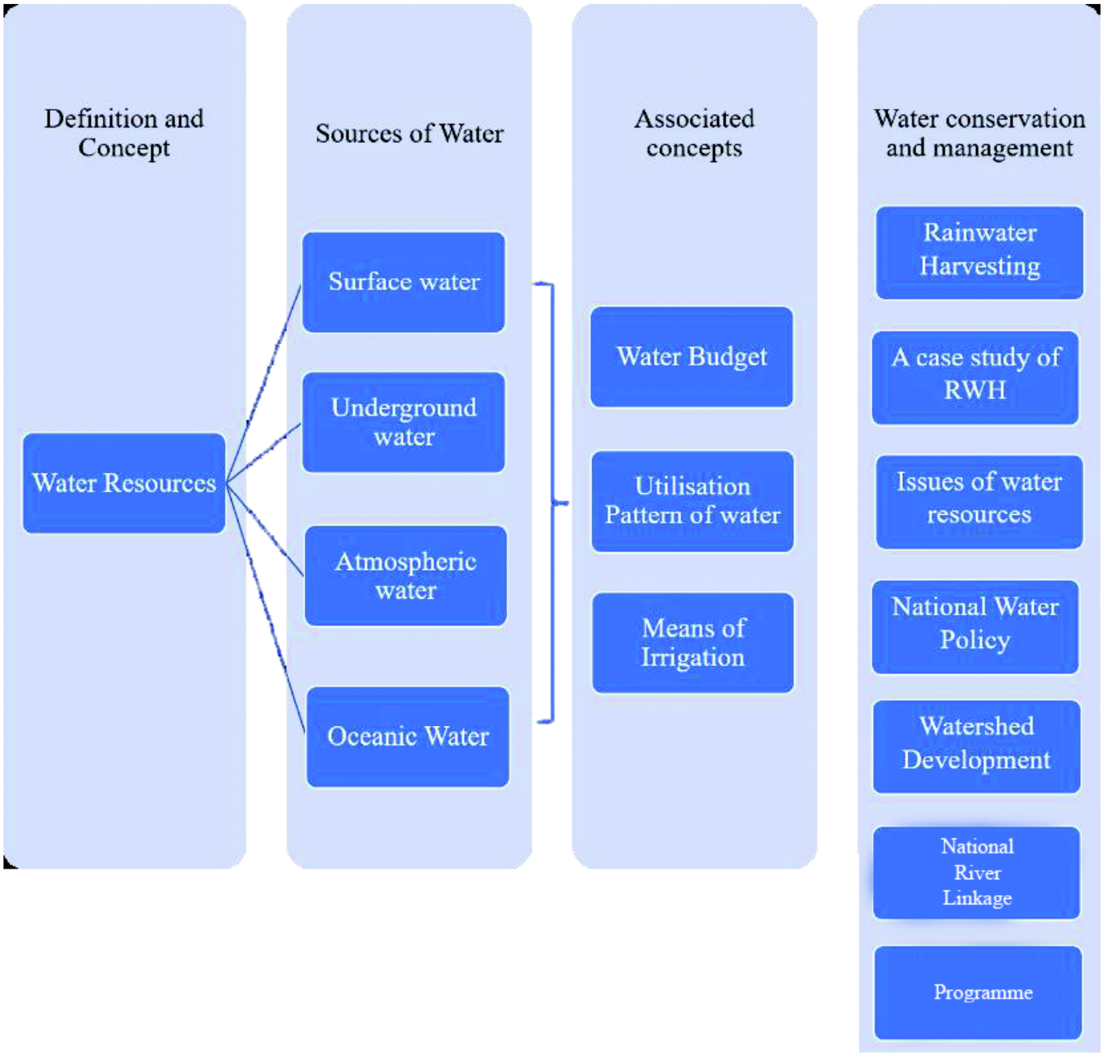
1. Mention any four problems related to water resources.

   a._____________b.____________c.____________d.___________

2. What is the main objective of the National Water Policy?

3. What are the challenges in interlinking rivers? Any two

WHAT YOU HAVE LEARNT



TERMINAL QUESTIONS

1. Answer the following questions in brief-

   (i) What is the meaning of water resources?

   (ii) Mention the main sources of surface water.

   (iii) Why is more underground water available in the northern great plains of the country?

   (iv) State the meaning of rain water harvesting.

   (v) Explain the meaning of watershed.

(vii) What are the benefits of the National River Linking Programme?

2. Differentiate among the following -

   (a) Surface water and underground water.

   (b) Rain water harvesting and watershed development.

3. Why is the distribution of water uneven in India? Explain with examples.

4. "Underground water is a reliable and continued resource of water supply". Prove the logic of this statement.

5. Describe main methods of rainwater harvesting.

6. Which benefits can be achieved by watershed development? Mention them.

7. Why are desired results not achieved by watershed development projects? Give reasons.

8. Why is water conservation essential? Explain different methods of water conservation.

9. Evaluate the utility and applicability of water-shed development programmes in India.

ANSWERS TO INTEXT QUESTIONS

16.1.

1. First
2. Ganga
3. Punjab, Haryana, Rajasthan, Tamil Nadu, Gujrat, UP (Any Five)

16.2.

1. Wells and tube wells, Canals, Tanks
2. Tamilnadu, Odisha, Maharashtra, Karnataka etc.
3. Regional and seasonal variations in rain, growing demand for commerical crops etc

16.3.

1. Scarcity of Surface water, dependancy on underground water, increasing urbanisation.

2. i) Construction of Potholes

   ii) Construction of trenches

   iii) Use of wells

   iv) Use of handpump

3. Water Pits

16.4.

1. a) Increasing demand of water for urbanisation

   b) Pollution

   c) Demand for economic activity

   d) Scarcity due to global change

2. To take cognizance of existing situatin of country's water resources

3. i) Project Feasibility

   ii) Environmental impact

   iii) Impact on society (Any 2)

MODULE -8

Economic Geography of India

17. Agriculture and Food Security
18. Mineral and Energy Resources
19. Major Industries and Industrial Complexes
20. Foreign Direct Investment (FDI), Transport, Communication and Trade

17

AGRICULTURE AND FOOD SECURITY

In the previous lessons, you studied climate, soils, various types of resources and human activities. In this lesson, you will study agriculture. Agriculture is the milestone in the history of human civilization, due to agriculture man settled at a particular place. India is a unique country from an agricultural point of view. Its vast area, rich soils, high percentage of cultivable land, wide climatic range and long growing season provides a solid base to agriculture. Agriculture is predominant economic activity in India, engaging nearly three-fifths of its working population. Though the share of the agricultural sector in gross domestic product has considerably declined to about one-fourth yet the importance of agriculture as an employment provider to the workforce especially in the countryside is very high. Obviously, agriculture forms the hub of the Indian economy as a large number of industries are also heavily dependent on agriculture for supply of raw materials. Agriculture involves not only crops raising but also animal ranching and fishing.

OUTCOMES

After studying this lesson, learner:

- analyses spatial and temporal variations in agricultural production since independence;
- describes production of cereal and non-cereal crops;
- identifies environmental and socio-economic implications of agriculture development and
- explains the concepts of food security and safety.

17.1 SIGNIFICANCE OF AGRICULTURE

Agriculture is an important part of India's economy and at present it is among the top two farm producers in the world. This sector provides approximately 52 percent of the total number of

jobs available in India and contributes around 18.1 percent to the GDP. Agriculture is the only means of living for almost two-thirds of the employed class in India. As stated by the economic data of financial year 2006-07, agriculture has acquired 18 percent of India's GDP. The agriculture sector of India has occupied almost 43 percent of India's geographical area. Agriculture plays a vital role in the Indian economy. Over 70 per cent of the rural households depend on agriculture. Agriculture is an important sector of the Indian economy as it contributes about 17% to the total GDP and provides employment to over 60% of the population. Indian agriculture has registered impressive growth over the last few decades. The food grain production has increased from 51 million tonnes (MT) in 1950-51 to 250MT during 2011-12 highest ever since independence. It is significant due to various reasons such as:

- **Agriculture plays a vital role in generating employment:** In India at least two-thirds of the working population earn their living through agricultural works. In India other sectors have failed to generate much employment opportunity for the growing working populations.
- **Agriculture makes provision for food for the ever increasing population:** Due to the excessive pressure of population labour surplus economies like India face rapid increase in the demand for food. It resulted in the increase in food production at a fast rate.
- **Contribution to capital formation:** There is general agreement on the necessity of capital formation. Since agriculture happens to be the largest industry in a developing country like India, it can and must play an important role in pushing up the rate of capital formation. If it fails to do so, the whole economic development will suffer a setback.
- **Supply of raw material to agro-based industries:** Agriculture supplies raw materials to various agro-based industries like sugar, jute, cotton textile and Vanaspati industries. Food processing industries are similarly dependent on agriculture. Therefore, the development of these industries entirely is dependent on agriculture.
- **Market for industrial products:** Increase in rural purchasing power is very necessary for industrial development as two- thirds of the Indian population live in villages. After the green revolution the purchasing power of the large farmers increased due to their enhanced income and negligible tax burden.

Let's Do Can you name some industries based on agricultural raw material?

INTEXT QUESTIONS 17.1

1. In which percentage, agriculture contributes to the GDP of India?
2. Name any two types of raw materials used by agro-based industries.

17.2 MAJOR PRACTICES IN AGRICULTURE

India has a long agricultural history, which dates back approximately ten thousand years. Today, India has the second-highest crop output in the world and agriculture-related jobs employ nearly 60% of the total workforce. However, as India's population grows, the country is having difficulties meeting the demand for food products like wheat and rice. There are different types of farming activities performed in India which are as follows:

a. **Subsistence farming:** This is one of the most popular farming techniques that can be seen in various parts of India. The farmer along with his family cultivates grains for themselves or for sale at the local market. The entire family works on the farm and most of the agricultural work is done manually here. Traditional methods of farming are followed by the farmers in their small farms. Since facilities like electricity and irrigation are generally not available to the poor farmers, they do not use fertilisers and high yielding varieties of seeds in their fields to the extent they should.

b. **Shifting Agriculture:** This way of farming is widely used by the tribal groups to grow crops. Firstly, the land is obtained by clearing a forested area and then crops are planted. While the land loses its fertility, another area of land is cleared and the crops are shifted there. The commonly grown crops in this type of farming are dry paddy, maize, millets and vegetables.

   This practice is known by different names in different regions of India. For example, it is called Jhum in Assam, Ponam in Kerala, Podu in Odisha, Bewar, masha, penda, and bera in Madhya Pradesh. But since it causes extensive soil erosion, the government has tried to discourage this practice of cultivation by tribal population.

c. **Intensive agriculture:** This farming practice can be seen in densely populated areas in India. It is an attempt to maximise the output of the land, through the use of every possible effort. It requires a huge amount of capital and human labour, more than one crop can be raised per year.

d. **Extensive agriculture:** This is the modern type of farming that can be seen largely in the developed world and in some parts of India. It relies largely on machinery as opposed to a human labour force and raises one crop per year.

e. **Commercial Agriculture:** The goal of commercial agriculture is high yield, so that produce can be exported to other countries for profit making. Wheat, cotton, sugarcane and corn are some commercial crops. They are grown in states of Gujarat, Punjab, Haryana, and Maharashtra.

f. **Plantation agriculture:** This style is often used for crops which require a lot of space and a long growing period, such as rubber, tea, coconut, coffee, cocoa, spices, and

Notes

fruits. Plantations are only capable of producing a single crop. Plantation agriculture is practised in Kerala, Assam, Karnataka, and Maharashtra.

g. **Dry land farming:** As the name suggests, dry land farming is practised in the more arid and desert-like areas of the country, including northwest and central India. Crops such as gram, jowar, bajra and peas have lower water requirements and can therefore be grown in these conditions.

h. **Wetland farming:** Many areas of India are affected by heavy monsoon rains and subsequent flooding. Well-irrigated areas, such as those in northeast India and the western ghats are suitable for rice, jute, and sugarcane farming.

i. **Terrace Agriculture:** The hill and mountain slopes are cut to form terraces and the land is used in the same way as in permanent agriculture. Due to scarcity of the availability of flat land, terraces are made to provide a small patch of level land. Soil erosion is also checked due to terrace formation on hill slopes.

j. **Mixed and Multiple Farming:** It refers to a system of growing agricultural crops as well as the raising of livestock. Whereas multiple farming refers to growing more than one crop in the same field. Usually, two different crops with varying periods of maturity are shown so that they compete with growth period and nutrients. For e.g. wheat and gram, wheat and mustard etc. This type of farming system is followed in regions where abundant rainfall is expected and good irrigation facilities are available. This farming system controls total loss from pests, diseases and drought. It also helps in maintaining the fertility of soil by nitrogen fixation.

k. **Dairy Farming:** Dairy farming involves the rearing of cattle for milk. The dairy farming is highly developed in Sweden and Denmark. However, it has spread to other parts of the world and is practised in areas near markets. It thrives in regions that enjoy temperate climate. It plays a vital part of the global food system and plays a prime role in the sustainability of rural areas.

INTEXT QUESTIONS 17.2

1. Write any two types of crops grown in wet farming?
2. Give any two examples of crops which may be commercial in one region and may provide subsistence in another region?
3. Name any two states where commercial agriculture is popular.
4. Write any two characteristics of subsistence farming.

17.3 CROPPING PATTERN IN INDIA

Cropping Pattern means the proportion of area under different crops at a point of time, changes in this distribution overtime and factors determining these changes. Cropping pattern in India is determined mainly by soil type and climatic factors i.e. rainfall and temperature. They are reflected in agricultural practices and cropping patterns of the country. India is geographically a vast country so it has various food and non-food crops which are cultivated in three main cropping seasons which are Rabi, Kharif and Zaid.

- **Rabi Crops:** The Rabi crops in the spring harvest or winter crop in India. It is sown every year in October and harvested every year in March. Wheat, Barley, Mustard, Sesame, Peas etc. are the major rabi crops in India.
- **Kharif Crops:** The crop from Kharif is India's summer crop or monsoon crop. Kharif crops are usually seeded at the beginning of July's first rain. India's major Kharif crops include Millets (Bajra and Jowar), Cotton, Soja, Sugarcane, Turmeric, Paddy (Rice), Maize, Moong (Pulses), Groundnut, Red Chillies etc.
- **Zaid Crops:** This crop is grown from March to June in some parts of the country. Prominent examples are Muskmelon, Watermelon, Cucurbitaceous family vegetables such as bitter gourd, pumpkin, ridged gourd and other crops.

17.4 MAJOR CROPS IN INDIA

A variety of food and non-food crops are grown in different parts of the country depending upon the variations in soil, climate and cultivation practices. Major crops grown in India can be classified into four categories:

- **Food Grains-** (Wheat, Rice, Maize, Millets and Pulses)
- **Cash Crops-** (Cotton, Jute, Sugarcane, Tobacco and Oilseeds)
- **Plantation Crops-** (Tea, Coffee, Coconut and Rubber)
- **Horticulture crops-** (Fruits and Vegetables)

A. Food Grains

The crops that are grown to feed the human population are known as food crops. There are a number of food crops grown in the country. Let's know some of the major food grains.

a. **Paddy :** India is an important centre of paddy cultivation. It is the staple food crop in a majority of regions in the country. paddy is a Kharif crop that requires high

Notes

temperature, heavy rainfall and high humidity for proper growth. The areas with less rainfall use irrigation for rice cultivation. The paddy is cultivated on the largest areas in India. paddy cultivation in India extends from 8° to35°N latitude and from sea level to as high as 3000 metres. Paddy crops need a hot and humid climate. The average temperature required throughout the life period of the crop ranges from 21° to 37° C. Deep fertile loamy or clayey soils are considered ideal for this crop. It requires considerable manual labour for sowing and transplantation. Total production of paddy during 2019-20 is estimated at record 117.94 million tons. It is higher by 8.17 million Tons than the five years' average production of 109.77 million tons. Major paddy producing states are shown in the given Map.

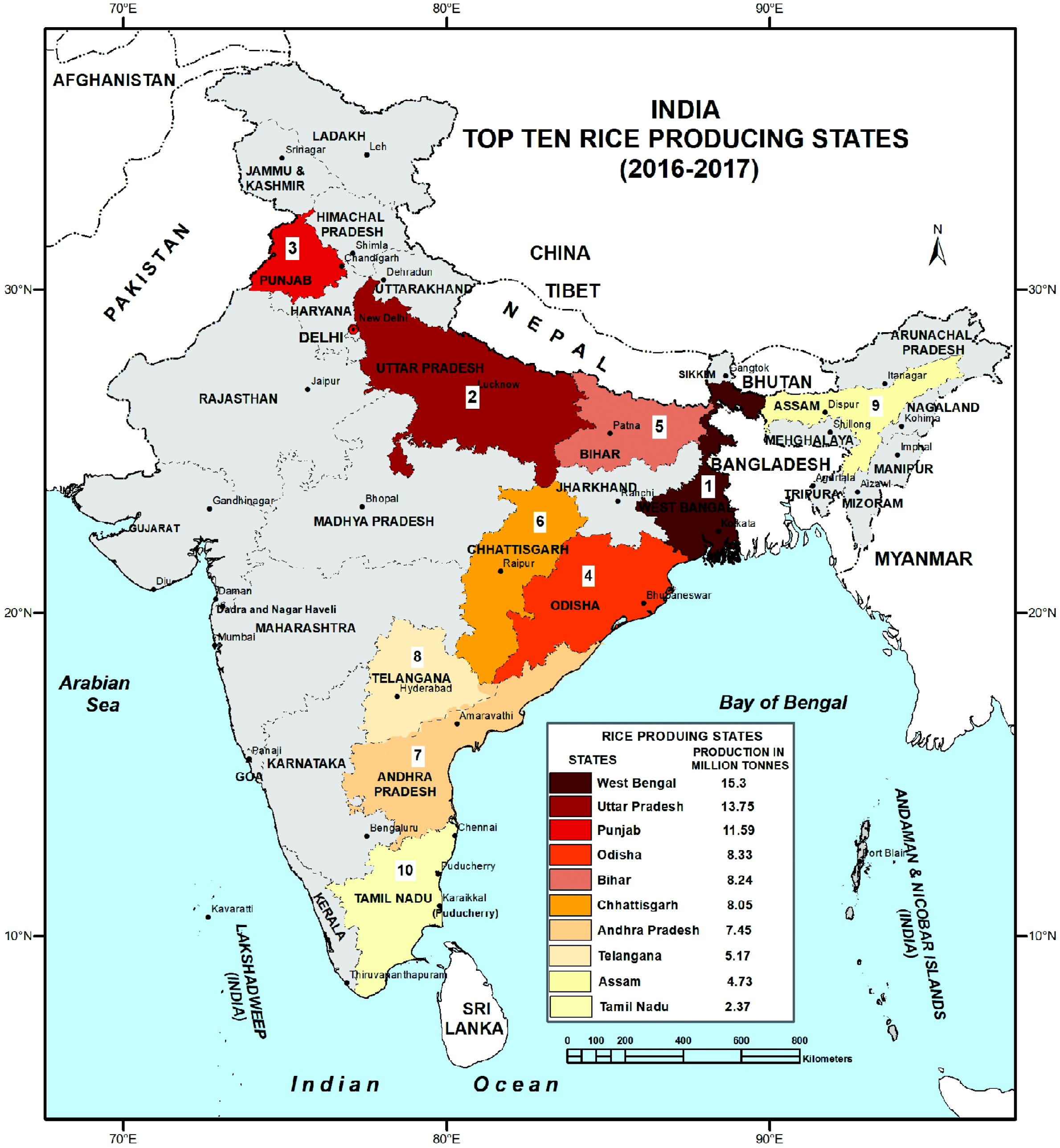


Fig 17.1 Major Rice Producing States of India

b. Wheat: Wheat is the main cereal crop of India. The total area under the crop is about 29.8 million hectares in the country. It can be grown not only in the tropical and sub-tropical zones, but also in the temperate zone and the cold tracts of the far north, even beyond the 60º N latitude. The best wheat is produced in areas favoured with cool, moist weather during the major portion of the growing period followed by dry, warm weather to enable the grain to ripen properly. The ideal temperature for the cultivation is about 15º-20ºC and requires moderate amounts of rainfall of 25-75 cms. The regions with a warm and damp climate are not suited for wheat growing. Production of wheat during 2019-20 was estimated at 107.18 million tons. It has increased by 3.58 million tons as compared to wheat production during 2018-19.The top four major wheat producing states of India are Uttar Pradesh, Punjab, Madhya Pradesh and Haryana.

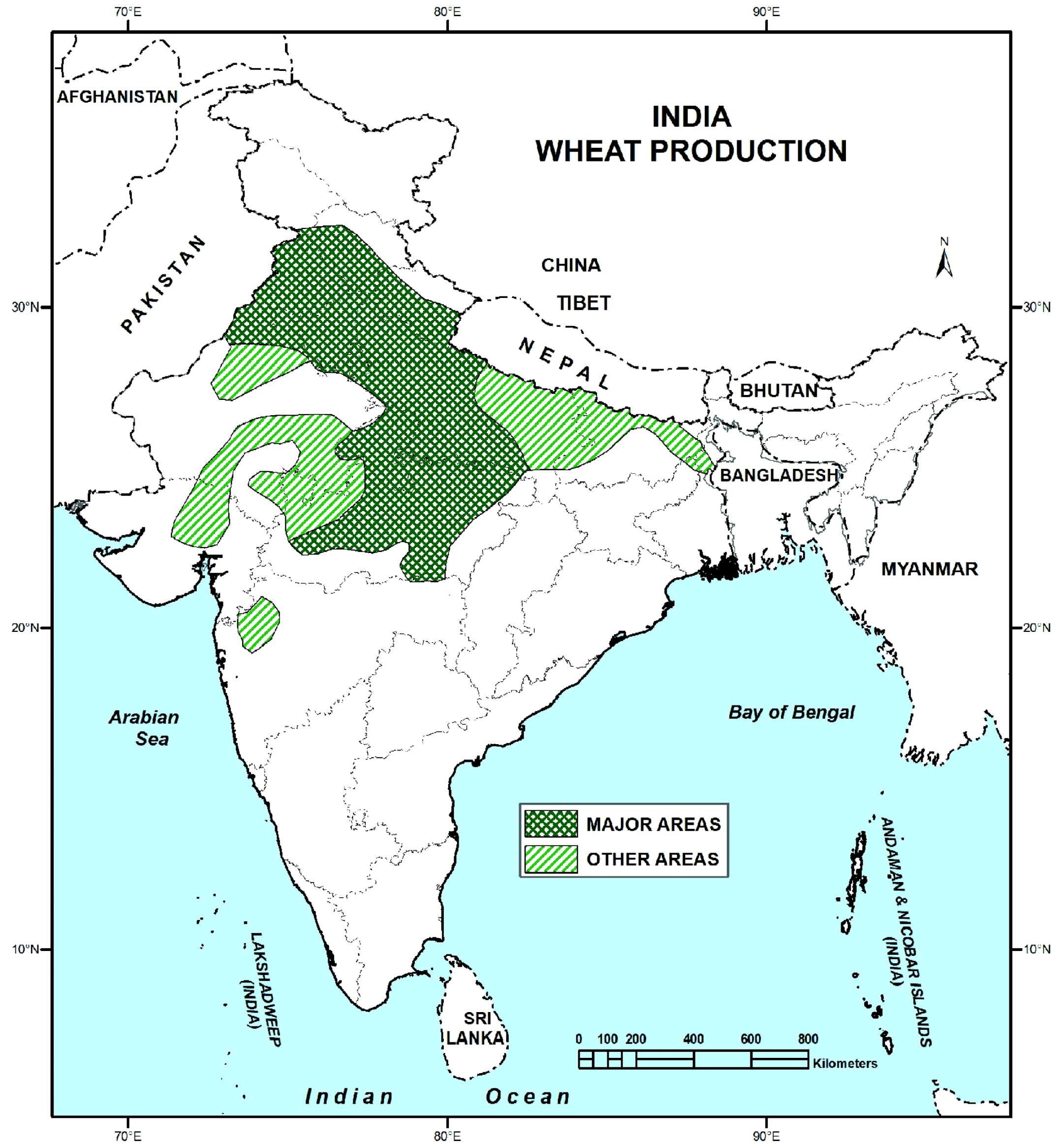


Fig. 17.2: Wheat Producing Areas

Notes

B. Cash Crops

a. **Sugarcane:** Sugarcane is a crop of tropical regions. Under rain fed conditions, it is cultivated in sub-humid and humid climates. Its cultivation is largely concentrated in Uttar Pradesh, Maharashtra and Gujarat. In southern India, it is cultivated in irrigated tracts of Tamil Nadu, Karnataka, Andhra Pradesh and Telangana. Uttar Pradesh produces about two-fifths of sugarcane of the country. India is the second largest producer of sugarcane after Brazil in 2015. It accounts for about 19 percent of the world production of sugarcane. But it occupies only 2.4% of the total cropped area in the country.

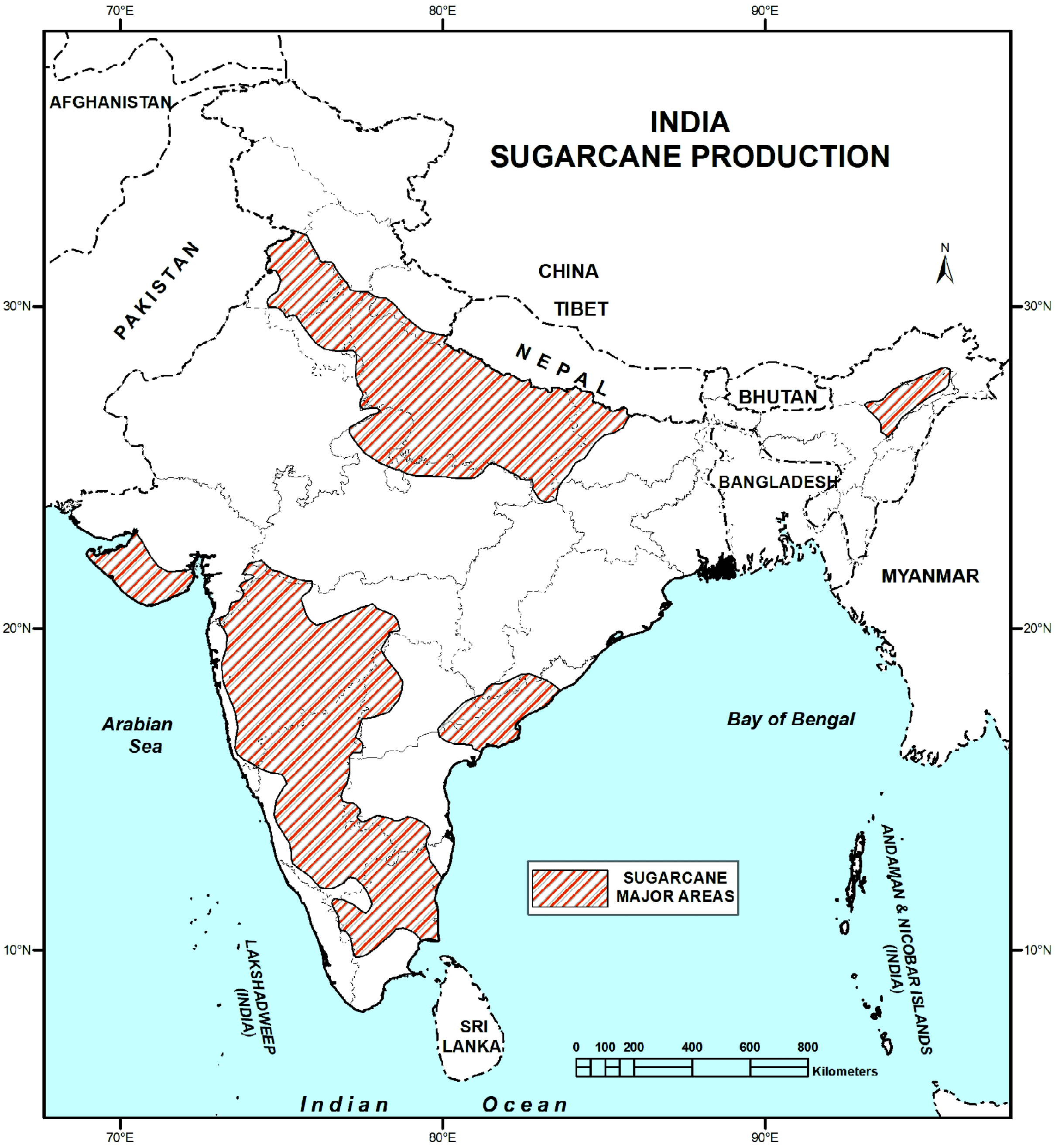


Fig. 17.3: Sugarcane Producing Areas

Notes

b. **Cotton:** Cotton is a Kharif Crop that grows in tropical and subtropical regions. India supports the growth of both short staple (Indian) and long staple (American) cotton called Narma in the north-western regions of the country. It grows in areas with a minimum of 210 frost free days in a year. It grows well in black soils of Deccan and Malwa plateau and also in Satluj-Ganga plain having red and laterite soils of the peninsular region. Leading producers of this crop are Gujarat, Maharashtra and Telangana.

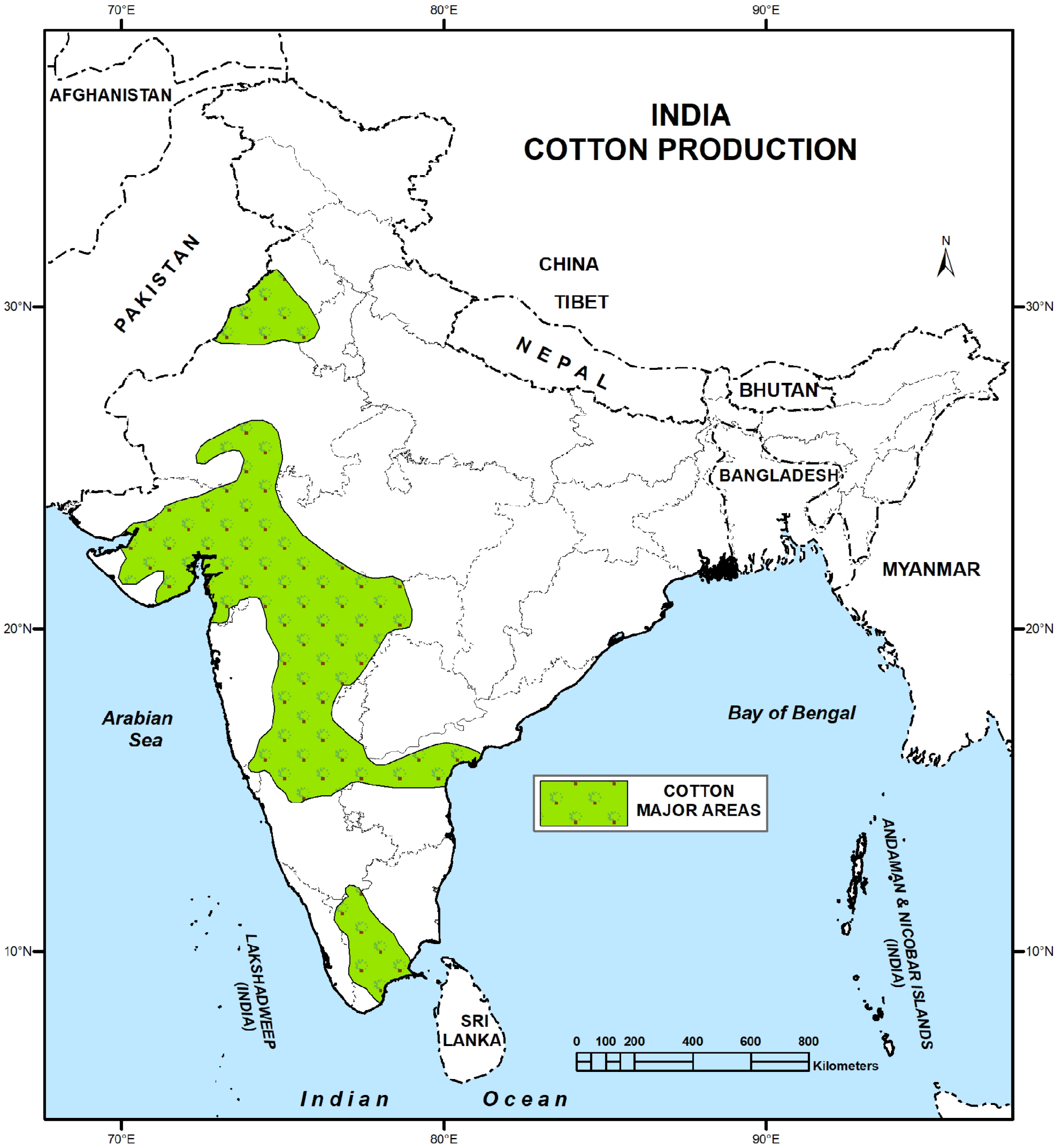


Fig. 17.4 : INDIA: Cotton Producing Areas

Notes

C. Plantation Crops

a. **Tea:** Tea is a plantation crop which is used as a beverage. Tea leaves are rich in caffeine and tannin. Tea is mostly grown in hilly areas and well drained soils in humid and subtropical areas. India is the world's largest black tea producer and consumer. Tea is grown in India in 16 states. Assam, West Bengal, Tamil Nadu, and Kerala make up around 95% of total tea production.

b. **Coffee:** Coffee is a tropical plantation crop. The seeds of coffee are roasted, ground and are used for preparing a beverage. Coffee needs a hot and humid climate ranging from 15°C to 28°C. Well-drained, rich loamy soil with humus and minerals is ideal for growing coffee. Coffee is cultivated in the highlands of Western Ghats in Karnataka, Kerala and Tamil Nadu which are the major coffee producing states in India.

D. Horticulture

a. **Fruits:** India accounts for about 10 percent of the production of fruits in the world. It leads the world in the production of mango, banana, sapota and lemons. A large variety of fruits are grown in India. Mango, bananas, citrus fruits, pineapple, papaya, guava, sapota, jackfruit, lichi and grapes are tropical and subtropical fruits. The fruits of temperate areas are apple, pear, peach, plum, apricot, almond and walnut which are grown mostly in the mountainous areas of the country. The important fruits of the arid zone of India are Amla, ber, pomegranate and figs.

b. **Vegetables:** India is the second largest producer of vegetables in the world next only to China. It contributes about 13 per cent to the world vegetable production. It occupies first position in the production of cauliflowers, second in onion, and third in cabbage in the world. Other major vegetable crops are potato, peas, tomato and brinjal. More than fifty varieties of vegetables are grown in India.

c. **Floriculture:** With breaking of trade barriers in the post-globalisation phase, international trade in vegetables, fruits and flowers has become lucrative. India can earn a sizable amount of foreign exchange by exporting flowers. Flowers such as rose, jasmine, marigold, chrysanthemum, tuberose, and aster are grown over large areas in Karnataka, Tamil Nadu, Andhra Pradesh, Rajasthan, West Bengal, Maharashtra, Delhi, Uttarakhand, Assam and Manipur.

Let's Do

- Collect different food grains and classify them according to seasons.

INTEXT QUESTIONS 17.3

1. Name two important fibre crops of India.
2. Which state is the largest producer of Rice in India?
3. Name two important sugarcane producing states in the country.
4. Name a major coffee producing state of India.

17.4 AGRICULTURAL DEVELOPMENT IN INDIA

Agricultural development is a must for the economic development of a country. "Agricultural progress is essential to provide food for growing non-agricultural labour force, raw materials for industrial production and saving and tax revenue to support development of the rest of the economy, to earn foreign exchange and to provide a growing market for domestic manufactures."Agriculture development implies giving assistance to farmers or crop producers by providing them various agricultural supports. Providing security, helping in the research area, employing advanced techniques, checking pests and facilitating diversity all fall under the category of agriculture development. In the colonial dominion, there was neither equity nor growth in the agricultural division. The strategy and rule makers of independent India addressed these problems through land reforms and advancing the use of'High Yielding Variety' (HYV) seeds which guided in a revolution in Indian agriculture.

A. Land Reforms

Land reform means equity in agriculture, which also means the shift in the ownership of landholdings. Land reform normally relates to the redistribution of land from rich to the poor. More deeply, it involves control of operation, ownership, sales, leasing, and inheritance of land. In recent years the theory of land reforms has expanded in the identification of the strategic role of land and agriculture in development. Therefore, Land reform has become similar to agrarian change or rapid development of the agrarian structure. This structure includes the land tenure system, farm organisation, the pattern of cultivation, the scale of the farm operation, the terms of tenancy, and the system of rural credit, marketing, and education. It also deals with advanced technology.

B. Green Revolution

After independence India had to rebuild its economy. Over three-quarters of the population depended on agriculture in some way. But agriculture in India was faced with several problems. Firstly, the productivity of grains was very low and Indian agriculture was dependent on the monsoon due to lack of irrigation and other

infrastructural facilities. India had previously faced severe famines during the British rule, who had only promoted cash crops instead of food crops. The idea was to never depend on any other country for food sufficiency. So in 1965, the government with the help of Indian geneticists M.S. Swaminathan, known as the father of Green Revolution, launched the Green Revolution. The movement lasted from 1967 to 1978 and was a great success.

Agriculture production was very less because of the practice of old technology. The Green Revolution started in 1965 with the introduction of High Yielding Variety (HYV) seeds in Indian agriculture. This was coupled with better and efficient irrigation and the correct use of fertiliser to boost the growth of the crops. This strategy of agriculture development increased the production of food grains in India. This also supported development of a large number of agro-inputs, agro-processing industries and small-scale industries. This method of agricultural development made India self-reliant in terms of food grain production.

Impact of the Green Revolution

a. **Increase in Agricultural Production:** Food grains in India saw a great rise in output. It was a remarkable increase. The biggest beneficiary of the plan was the Wheat crop. The production of wheat increased from 11 million tons in 1960 to 55 million tons in 1990.

b. **Increase in Per Acre Yield:** Green Revolution not only resulted in increased agricultural output, but has also caused increase in per hectare yield. In the case of wheat, the per hectare yield increased from 850 kg/hectare in 1960 to 2281 kg/hectare by 1990.

c. **Less Dependence on Imports:** After the green revolution, India was finally on its way to self-sufficiency. There was enough food production for the population and food stock for emergencies. We did not need to import grains or depend on other countries for our food supply. In fact, India was able to start exporting its agricultural produce.

d. **Employment:** It was feared that commercial farming would leave a lot of the labour force jobless. But on the other hand, we saw a rise in rural employment. This is because the supporting industries created employment opportunities. Irrigation, transportation, food processing, marketing all created new jobs for the workforce.

e. **A Benefit to the Farmers:** The Green Revolution majorly benefited the farmers. Their income saw a significant raise. Not only were they surviving, they were prospering. It enabled them to shift to commercial farming from only sustenance farming.

C. White Revolution

The revolution associated with a sharp increase in milk production in the country is called the White Revolution in India also known as 'Operation Flood'. White revolution period intended to make India a self-dependent nation in milk production. Today, India is the world's largest producer of milk and Dr. Verghese Kurien is known as the father of the White Revolution in India. During the year 1964-1965, the Intensive Cattle Development Programme was introduced in India in which the cattle owners were provided with a package of improved animal husbandry for promoting the white revolution in the country. Later on, the National Dairy Development Board introduced a new programme named "operation flood" to increase the speed of the white revolution in the country. Operation Flood started in the year 1970 and was aimed to create a nationwide milk grid. It was a rural development programme initiated by NDDB - National Dairy Development Board of India. Village milk producer's cooperatives laid the foundation of the operation flood. With the optimum use of modern technology and management, they procured milk and provided the services. White Revolution had the objectives as stated below:

- Creating a flood of Milk by Increase production
- Increase the incomes of the rural population
- Provide milk to consumers at fair prices

Significance of Operation Flood

a. The White Revolution in India helped in reducing malpractice by traders and merchants. It also helped in eradicating poverty and made India the largest producer of milk and milk products.

b. Operation Flood empowered the dairy farmers with control of the resource created by them. It helped them in directing their own development.

c. To connect milk producers with the consumers of more than 700 cities and towns and throughout the country, a 'National Milk Grid' was formed.

d. The revolution also reduced regional and seasonal price variations ensuring customer satisfaction and at the same time. Also, it ensured that the producers get a major share of the price that customers pay.

e. Improved the living standards of the rural people and led to the progress of the rural economy.

Let's Do

- Collect some dairy farming products with farm photographs.

D. Blue Revolution

The Blue Revolution was launched in India during the 7th Five Year Plan (1985-1990) during the sponsorship of the Fish Farmers Development Agency (FFDA) by the Central Government of India. Later, during the 8th Five Year Plan (1992-97), the Intensive Marine Fisheries Programme was launched, and eventually, the fishing harbours in Visakhapatnam, Kochi, Tuticorin, Porbandar, and Port Blair were also established over the time. The Nili Kranti Mission aimed to enhance the economic condition of India through the augmentation of fisheries and thus contributing towards food and nutritional security. The utilisation of the water resources for the development of fisheries was done by the Neel Kranti Mission in a sustainable manner.

The Blue Revolution in India along with the Fish Farmers Development Agency (FFDA) brought an improvement in the aquaculture and fisheries sector with the introduction of new techniques of rearing, marketing, exporting, and fish breeding. Some of the major outcomes of the Blue Revolution in India are mentioned below:

- Currently, the Indian Fisheries Sector reached a production of 4.7 million Tons of fish from a limit of 60,000 tons including 1.6 million tons of fish from freshwater aquaculture.
- India is recorded to achieve an average annual growth of 14.8% as compared to the global average percentage of 7.5% in the production of fish and fish products.
- The fishery has become India's largest agricultural export over the last five years with a growth rate of 6% - 10%.
- India has become the world's second-largest producer of fish with exports worth more than 47,000 crore rupees.
- The fisheries and aquaculture production contributes 1% and 5% to India's GDP and Agricultural GDP respectively.

E. Yellow Revolution

The term yellow revolution has been adopted to express the remarkable increase in oilseed production in India which started in 1986. The objective of the yellow revolution is to achieve self-reliance in the production of oilseeds. Oilseed's technological mission was launched to ensure optimum utilisation of production, processing, management and technology in oilseed crops. The impact of the yellow revolution and its success had a dramatic increase from 10.83 million tons in 1985-86 to 24.75 million tons in 1998-99. However, after that, we have not been able to achieve self-sufficiency in oilseeds. A second yellow revolution is the crying need of the hour. Also, a technical

invention in dry land farming is required to maximise yield, productivity, and farm income. Achieving the aim of making the nation self-sufficient in oilseeds would have a significant impact on agriculture and the economy and would serve to reduce dependence on foreign markets.

17.5 ENVIRONMENTAL AND SOCIO-ECONOMIC IMPLICATION

The Green revolution was highly successful as agricultural production in most countries increased. India which was once dependent on import of food grains for satisfying the needs of its population gradually became an exporter of food grains. The green revolution has both positive and negative impacts on environments and socio-economic conditions.

A. Environmental Implication

a. **Loss of Biodiversity:** The spread of Green Revolution agriculture affected both agricultural biodiversity and wild biodiversity. There is a little disagreement that the Green Revolution acted to reduce agricultural biodiversity, as it relied on just a few high-yield varieties of each crop. For example, before the revolution, it is speculated that there were over 3000 variants of rice. Now it is estimated that only ten modified varieties of rice are used. This has led to concerns about the susceptibility of a food supply to pathogens that cannot be controlled by agrochemicals, as well as the permanent loss of many valuable genetic traits bred into traditional varieties over thousands of years.

b. **Dependence on non-renewable resources:** Most high intensity agricultural production is highly reliant on non-renewable resources. Agricultural machinery and transport, as well as the production of pesticides and nitrates all depend on fossil fuels. Moreover, the essential mineral nutrient phosphorus is often a limiting factor in crop cultivation, while phosphorus mines are rapidly being depleted worldwide. The failure to depart from these non-sustainable agricultural production methods could potentially lead to a large-scale collapse of the current system of intensive food production within this century.

c. **Salinization:** The continuous supply of moisture through irrigation during the summer and winter seasons have changed the soil chemistry. In the arid and semi-arid areas, owing to capillary action, the soils are becoming either acidic or alkaline. The saline and alkaline affected tracts, locally known as kallar or thur in Punjab and kallar or reh in Uttar Pradesh have expanded and increased in area According to one estimate, about 50 percent of the total arable land of Punjab and Haryana has been harmed by soluble salts.

d. **Soil Erosion:** Soil erosion is a universal phenomena. It may be observed to some extent in all parts of the country; its intensity, however, is more in the arid, semi-arid, and mountainous areas. The presence of forests reduces the danger of soil erosion significantly. In recent years, the agricultural area has been expanded by indiscriminate felling of trees. The increase in the rate of soil erosion is not only damaging the agricultural lands, it is also adversely affecting the areas where the eroded soil is deposited.

e. **Decline in soil fertility:** The High Yielding Varieties perform better if heavy doses of chemical fertiliser, insecticides, and pesticides are applied. Application of heavy doses of these inputs destroy the micro-organisms which are so necessary to maintain the fertility of the soil.

f. **Lowering of the Underground Water-Table:** The High Yielding Varieties of rice and wheat are water-relishing crops. The continuous lifting of water through tube-wells and pumping sets has lowered the water Table in the eastern districts of Haryana. Many farmers have to lower their tube-wells in the years of inadequate monsoon rainfall. If the cropping pattern is not changed, and irrigation of rice and wheat continues at the present level, the underground water-table may not be sufficiently recharged and may get substantially depleted.

In opposition to this, the underground water-table in western Haryana is rising as there is a gypsum layer in that part of the state which does not permit the percolation of water through this layer; the water-table in the Jhajjar District of Haryana has risen significantly. The crops of millets, bajra, arhar are damaged. Consequently, there are waterlogged conditions in several tracts in the western parts of Haryana. This rise in the water-table is resulting in capillary action, leading to the occurrence of saline and alkaline formations.

g. **Deforestation:** There had been heavy felling of trees to bring the forest area under cultivation. In Punjab and Haryana, less than 5 percent of their area is under forest. This is affecting the environment and ecology adversely.

B. Socio-economic implications

a. **Higher productivity and self- sufficiency in food grains production:** Agricultural productivity increased sharply and India became self-sufficient in food grain production in a decade.

b. **Increases inequality in rural society:** The larger and medium farmers only afforded the high input cost, small and marginal farmers could not afford this high input cost and were left unbenefitted. Farmers benefited most of those who were able to access land, capital, technology, and knowledge. Those who do not have

much land are only able to produce for family consumption; those who were able to produce much are able to sell in the market and get benefitted most. Rich farmers become richer and poor farmers do not benefit much.

c. **Displacement of tenant cultivators:** Prior to the green revolution, the tenant cultivators got land as a lease from the landlord as landlords had too big land to do cropping by using the traditional agricultural tools. After the induction of new agriculture technology and modern agriculture tools, landlords get back their own land from the tenant which leads to tenant displacement.

d. **Displacement of Rural-Urban Migration:** Service cast groups such as tractors, threshers, and harvesters increase leads to rural-urban migration. Labour worker migration increased from drought-prone areas to irrigated areas as the demand for labour increased when the green revolution was introduced.

e. **The wage of rural workers does not increase despite high productivity:** The mode of payment also shifted from food grains to cash. The above two worsened the economic condition of most of the workers.

f. **Commercialization and dependency on market:** The second phase of the green revolution was introduced in the semi-arid region in India. Cropping pattern changes and cash crops such as cotton are grown for the market. Market-oriented single crops such as cotton and bananas are grown. Commercialization and dependency on the market increase livelihood insecurity; a fall in price or bad crops increases the insecurity. Mono crop culture also increases the chance of crop failure and leads to nutrient depletion in the soils.

g. **Increase regional inequality:** The first phase of the green revolution was implemented in the limited part of the country where assured irrigation was available as the result Punjab, Haryana, Western UP, and part of Tamil Nadu become more developed as compared to eastern UP, Bihar, Odisha, West Bengal, and other parts of the country. It leads to regional inequality.

INTEXT QUESTIONS 17.4

1. Who is called the father of the green revolution?
2. Write two key features of the green revolution.
3. In which five year plan the Intensive Marine Fisheries Programme?
4. Write any two environmental implications of the green revolution.

Notes

17.6 FOOD SECURITY IN INDIA

Ensuring food security ought to be an issue of great importance for a country like India. There have been many emerging issues in the context of food security in India in the last two decades. According to the Food and Agriculture Organization (FAO), food security exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life. Food security is the combination of the following three elements:

a. **Food availability-** food must be available in sufficient quantities and on a consistent basis. It considers stock and production in a given area and the capacity to bring in food from elsewhere, through trade or aid.

b. **Food access-** people must be able to regularly acquire adequate quantities of food, through purchase, home production, barter, gifts, borrowing or food aid.

c. **Food utilisation-** Consumed food must have a positive nutritional impact on people. It entails cooking, storage and hygiene practices, individual's health, water and sanitation, feeding and sharing practices within the household.

Food security is closely related to household resources, disposable income and socio-economic status. It is also strongly interlinked with other issues, such as food prices, global environment change, water, energy and agriculture growth. India's food security policy has a primary objective to ensure availability of food grains to the common people at an affordable price. It has enabled the poor to have access to food. The focus of the policy is on growth in agriculture production and on fixing the support price for procurement of wheat and rice, to maintain their stocks. Food Corporation of India (FCI) is responsible for procuring and stocking food grains, whereas distribution is ensured by public distribution system (PDS).

We already know that the consumers are divided into two categories: below poverty line (BPL) and above poverty line (APL), with the issue price being different for each category. However, this categorization is not perfect and a number of deserving poor have been excluded from the BPL category. Moreover, some of the so-called APL slips back to BPL, because of the failure of even one crop and it is administratively difficult to accommodate such shifts. Each district and block can be made self-sufficient in food grain production with the help of government by providing proper agricultural infrastructure, credit linkages and also encourages the use of latest techniques. Instead of concentrating only on rice or wheat, the food crop with a better growth potential in that particular area must be encouraged. Creation of necessary infrastructure like irrigation facilities, availability of electricity etc. may also attract private investments in agriculture.

There has been a gradual shift from cultivation of food crops to cultivation of fruits, vegetables, oil-seeds and industrial crops. This has led to the reduction in net sown area under cereals and pulses. With the growing population of India, the declining food production puts a big question mark over the country's future food security. The competition for land between non-agricultural uses such as housing etc. and agriculture has resulted in reduction in the net sown area. The productivity of land has started showing a declining trend. Fertilisers, pesticides and insecticides which once showed dramatic results, are now being held responsible for degrading the soils. Periodic scarcity of water has led to reduction in area under irrigation. Inefficient water management has led to water logging and salinity.

Role of Cooperatives in Food Security

The cooperatives are also playing an important role in food security in India especially in the southern and western parts of the country. The cooperative societies set up shops to sell low priced goods to poor people. For example, out of all fair price shops running in Tamil Nadu, around 94% are being run by the cooperatives. In Delhi, Mother Dairy is making strides in provision of milk and vegetables to the consumers at a controlled rate. Amul is another success story of cooperatives in milk and milk products from Gujarat. It has brought about the White Revolution in the country. These are a few examples of many more cooperatives running in different parts of the country ensuring food security of different sections of society.

Impact of Globalization on Agriculture

Globalisation is not a new phenomenon. It was there at the time of colonisation. In the 19th century when European traders came to India, at that time too, Indian spices were exported to different countries of the world and farmers of south India were encouraged to grow these crops. Till today it is one of the important items of export from India.

Under globalisation, particularly after 1990, the farmers in India have been exposed to new challenges. Despite being an important producer of rice, cotton, rubber, tea, coffee, jute and spices our agricultural products are not able to compete with the developed countries because of the highly subsidised agriculture in those countries. Today, Indian agriculture finds itself at the crossroads. To make agriculture successful and profitable, proper thrust should be given to the improvement of the condition of marginal and small farmers. The green revolution promised much. But today it's under controversy. It is being alleged that it has caused land degradation at some places due to overuse of chemicals, drying aquifers and vanishing biodiversity. The keyword today is "gene revolution". This includes genetic engineering. In fact organic farming is much in vogue today because it is practised without factory made chemicals such as fertilisers and pesticides. Hence, it does not affect the environment in a negative manner.

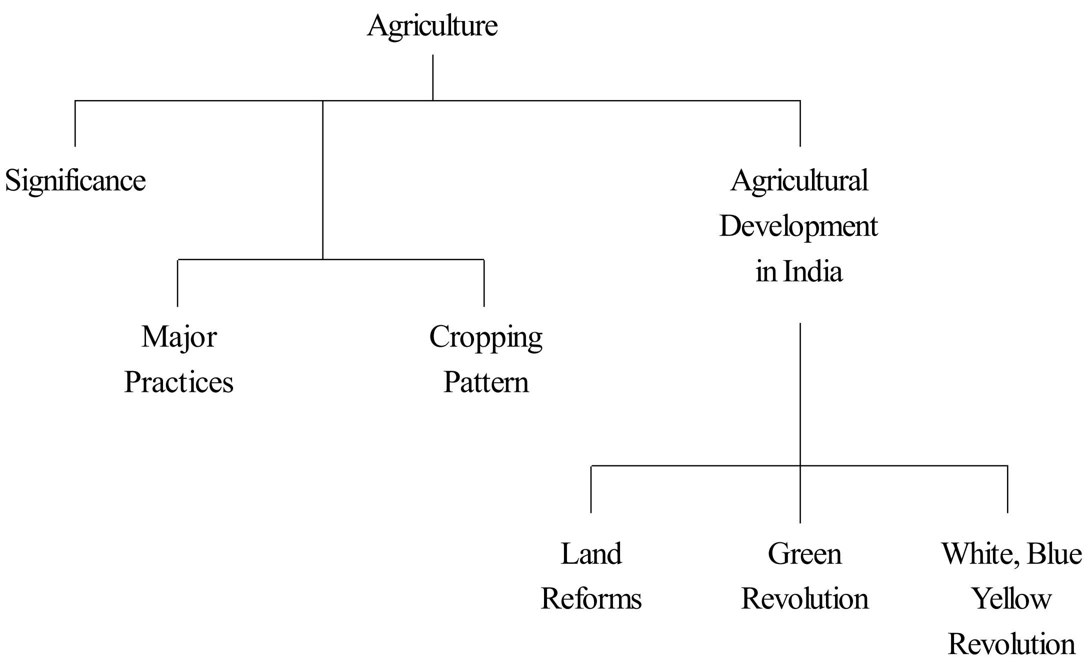
Notes

India's rural population is about 600 million which depends upon 250 million (approximate) hectares of agricultural land, an average of less than half a hectare per person. Indian farmers should diversify their cropping pattern from cereals to high-value crops. This will increase incomes and reduce environmental degradation simultaneously. Because fruits, medicinal herbs, flowers, vegetables, biodiesel crops like jatropha and jojoba need much less irrigation than rice or sugarcane. India's diverse climate can be harnessed to grow a wide range of high-value crops.

INTEXT QUESTIONS 17.5

1. Name the organisation responsible for procuring and stocking food grains in India.
2. Give any one example of cooperative organisation.

WHAT YOU HAVE LEARNT



TERMINAL QUESTIONS

1. What are the sustainability principles in food and agriculture?
2. How to achieve sustainable agricultural productivity?
3. What is the minimum support price?
4. Explain the major dimensions of food security with suitable examples.
5. How is food security ensured in India?
6. What do you mean by 'Operation Flood'?
7. Describe the geographical conditions required for the growth of rice and wheat.
8. Describe the impact of globalisation on Indian agriculture.

ANSWERS TO INTEXT QUESTIONS

17.1

1. 18.1
2. Sugar, Jute, Cotton

17.2

1. Rice, Jute, Sugarcane
2. Wheat, Corn
3. Gujrat, Punjab, Haryana etc.
4. i) Farmer works with family

   ii) Traditional methods are used

17.3

1. Cotton , Jute
2. West bengal
3. U.P., Maharashtra, Tamilnadu
4. Karnataka, Kerala

17.4

1. M.S. Swaminathan
2. i) Increase in Agriculture Production

   ii) Increase in per Acre Yield
3. Five year plan
4. i) Loss of Biodiversity

   ii) Salization.

17.5

1. Food Corporation of India
2. Amul

18

MINERAL AND ENERGY RESOURCES

In the previous lesson you learned about the agricultural resources of India and how it is providing food security to its people. Prosperity of a country is based on the availability of resources. You have also learned how India is rich in its natural resources. The development of a country can not be imagined without optimum use of resources. The resources may be of various kinds. Minerals like land and water are invaluable treasures of the earth. Without these resources, we cannot think of industrialisation and hence the development of our economy. The social and economic development of a nation depends on its capacity to utilise its natural resources, reducing the misuse to the extent possible. The most important characteristics of minerals which have bearing on our present and future well-being is that they are not permanent and can disappear with time after use. These resources are non-renewable. Therefore, there is now more emphasis on judicious use of these resources to conserve and to recycle them.

In this lesson, you will study some of the important minerals and energy resources, their significance and distribution along with the need and way of conservation.

OUTCOMES

After studying this lesson, learner:

- states the significance of mineral and energy resources in the national economy;
- describes the spatial distribution of different types of mineral resources;
- differentiates between conventional and non-conventional energy resources;
- describes the spatial distribution of different types of energy resources and
- asseses the development of non-conventional energy resources.

Notes

18.1 MINERAL AND ENERGY RESOURCES: SIGNIFICANCE AND ROLE IN ECONOMY

India is rich in minerals possessing diverse varieties of minerals. But do you know that all minerals are not economically significant. Out of these minerals, about 30 minerals have economic significance. Some of the major minerals are iron ore, coal, manganese, bauxite, mica etc. Felspar, florides, lime- stones, dolomite and gypsum etc are some other important minerals. But there are some minerals which are not abundant in India i.e. petroleum and some non-ferrous metallic minerals especially copper, lead, zinc, tin and graphite. Country fulfils internal demands for these minerals by importing them from other countries.

Before independence, India was least industrialised if we talk about the modern industries and these minerals were less in demand. Hence, most of the minerals were exported during the British period. After independence, situations begin to change. However, the exports of these minerals were continued but also mineral production has picked up in consonance with the increasing industrial demands in the country.

India produces more than 90 minerals, which are suitable for the growth of the country. The total value of all minerals produced in the country in 1950-51 was Rs 892 million. We have seen multiple times growth in the production and utilisation of minerals in the last 75 years after independence. As per the Annual Report- 2021-22 of Ministry of Mine, Govt. of India, the total value of minerals produced (excluding atomic, fuel minerals and minor minerals) during 2021-22 was estimated at Rs.1,90,389 crores. Out of this total estimated value, 55.2% was from metallic minerals and 44.8 were from non-metallic minerals.

In metallic mineral category, iron ore, chromite, manganese, zinc, bauxite, copper, gold are important minerals whereas in non-metallic category lime- stone, phosphorite, dolomite, kaolin, magnesite, barytes and gypsum are important. India's contribution in the production of these minerals in the world is also significant as it holds very high ranks in world order. For example India ranks 3rd in Chromite, 5th in Bauxite, 4th in Iron ore, 7th in manganese ore and the list goes on. The huge reserves and production in big quantities has made India self-sufficient or partially self-sufficient in many minerals. For example, in the year 2019-20 India was self-sufficient in bauxite, chromite, iron ore, limestone and sillimanite. While in some minerals it was not totally self-sufficient and the remaining portion was imported. For example, we were 75% self-reliant in magnesite, 15% in rock phosphate and 51% manganese ore and remaining percentages were imported. The availability of these resources has helped in the growth of industry. Iron and steel Industries, petroleum industry, fertilisers industry, aluminium industry etc. has grown tremendously by using these resources. But in certain cases if minerals are imported then a large amount of foreign reserves are spent on such imports. India expends a huge amount on petroleum products as its reserves are not sufficient in India. The availability and concentration of these minerals also influence the concentration of industries in any specific area.

The same was with energy resources. Energy resources are the fuel for the development of any country. It may have varied form as per the utilisation. With changes and development in technologies, the form of energy has also been changed. It is useful for day to day life and we can not think about industrial development without optimum availability of energy resources. The total installed power generation capacity of India in 2022 was 410,339 MW. It includes 2,35,809 MW (57.5%) from fossil fuels and 1,74,530 MW (42.5%) from non-fossil fuels.

Till now we have discussed in detail about the minerals and energy resources that are found in our country and how they are significant to our economic growth. In the next section, we will find out their geographical distribution.

INTEXT QUESTIONS 18.1

1. The value of minerals produces in 1950-51 was:

   a. Rs 756 million

   b. Rs 852 million

   c. Rs 892 million

   d. Rs 1050 million

2. What was India's installed power generation capacity in 2022 ?

   a. 510,330 MW

   b. 410,339 MW

   c. 673,545 MW

   d. 234,534 MW

3. In which of the following minerals, India is not self - sufficient?

   a. Rock phosphate

   b. Bauxite

   c. Chromite

   d. Iron ore

18.2 SPATIAL DISTRIBUTION OF MAJOR MINERALS

If you observe the distribution of mineral and energy resources, you will find that they are not equally distributed. The reason behind it is that these are associated with certain types of

geological formation. For example, coal deposits are mostly associated with the Gondwana system while major metallic minerals are found in the area of Dharwad and Cuddapah. Most of the mineral bearing states are located in the peninsular plateau region of India. We can find three specific belts of mineral distribution in peninsular plateau region:

- **The North eastern plateaus:** It covers chota nagpur plateau, Odisha plateau and eastern Andhra plateau. This belt contains rich deposits of a variety of minerals, especially used for metallurgical industries. Prominent minerals that are large and widely distributed are iron ore, manganese, mica, bauxite, limestone, dolomite etc. This region also has rich deposits of coal, along the river valleys of Damodar, Mahanadi, Son etc. This region also has substantial deposits of copper, uranium, thorium, phosphate etc.

- **South-western plateaus:** This region extends over Karnataka plateau and adjoining Tamil Nadu plateau and is rich in metallic minerals particularly in iron ore, manganese and bauxite and in some non-metallic minerals. All the three gold mines of India are found in this region. However, coal is not found in this plateau region.

- **North-western region:** This belt extends from the gulf of Khambhat in Gujarat to the Aravalli range in Rajasthan. Petroleum and natural gas are principal resources of this belt. Deposits of other minerals are small and scattered. However, it is known for reserves and production of several non-ferrous metals particularly copper, silver, lead, and Zinc.

Minerals are broadly divided into two groups metallic and non-metallic minerals. Metallic minerals are further subdivided into ferrous and non ferrous minerals. Let's find some of the important minerals of India, their occurrence and distribution.

A. Metallic Minerals

The minerals under this category sufficiently contain metal content. It can be further subdivided into ferrous metallic and ferrous non-metallic minerals.

a. **Ferrous Metallic Minerals:** Ferrous minerals constitute one of the most important mineral groups. Iron, manganese, chromite, pyrite etc are included in this category. These minerals provide a strong base for the development of metallurgical industries, particularly iron, steel and alloys.

i. **Iron Ore:** India has vast reserves of good quality iron ore and comes among the one of the top countries of the world. It is estimated that India possesses over 20 percent of the world's total reserves of iron ore. The quality of ore found in India is very high, containing above 60% iron content.

India's reserves contain three types of iron ore- Haematite, magnetite and limonite. Haematite ore, referred to as 'red ore' due to its red colour, contains up to 68 percent of iron. The magnetite ore with dark brown to blackish in colour, and often referred as 'black ores' contains up to 60 percent of the iron. Third one is limonite which has an iron content of 35-50 percent and is yellow in colour.

DO YOU KNOW?

The classification of reserves/resources of various minerals is mostly based on United Nations Framework Classification (UNFC) and was done in April, 2010. It consist of three dimensional system with three axes - economic viability, possibility assessment and geological assessment.

As per UNFC system total estimated resources of hematite (as of 2015) are estimated at 22,487 million tonnes which includes 5442 million tonnes as reserve category while balance 17,045 million tonnes are under the remaining category. Another main iron ore is magnetite, which has a total resource of 10,789 million tonnes. Out of this resource 53 million tonnes is under reserve category while 10,736 million tonnes are under the remaining category. India was the 4th major iron ore producing country of the world in the year 2019-20 and its contribution was 8.09% of the total world's production.

Table 18.1 Production of iron ore in India

Year	Production (In million tonnes)
1950-51	3.0
1960-61	11.0
1970- 71	32.5
1980-81	42.2
1990-91	53.7
2004-05	140.46
2019-20*	246.0

* - As per Annual Report- 2021-22, Ministry of Mines, Govt. of India

Notes

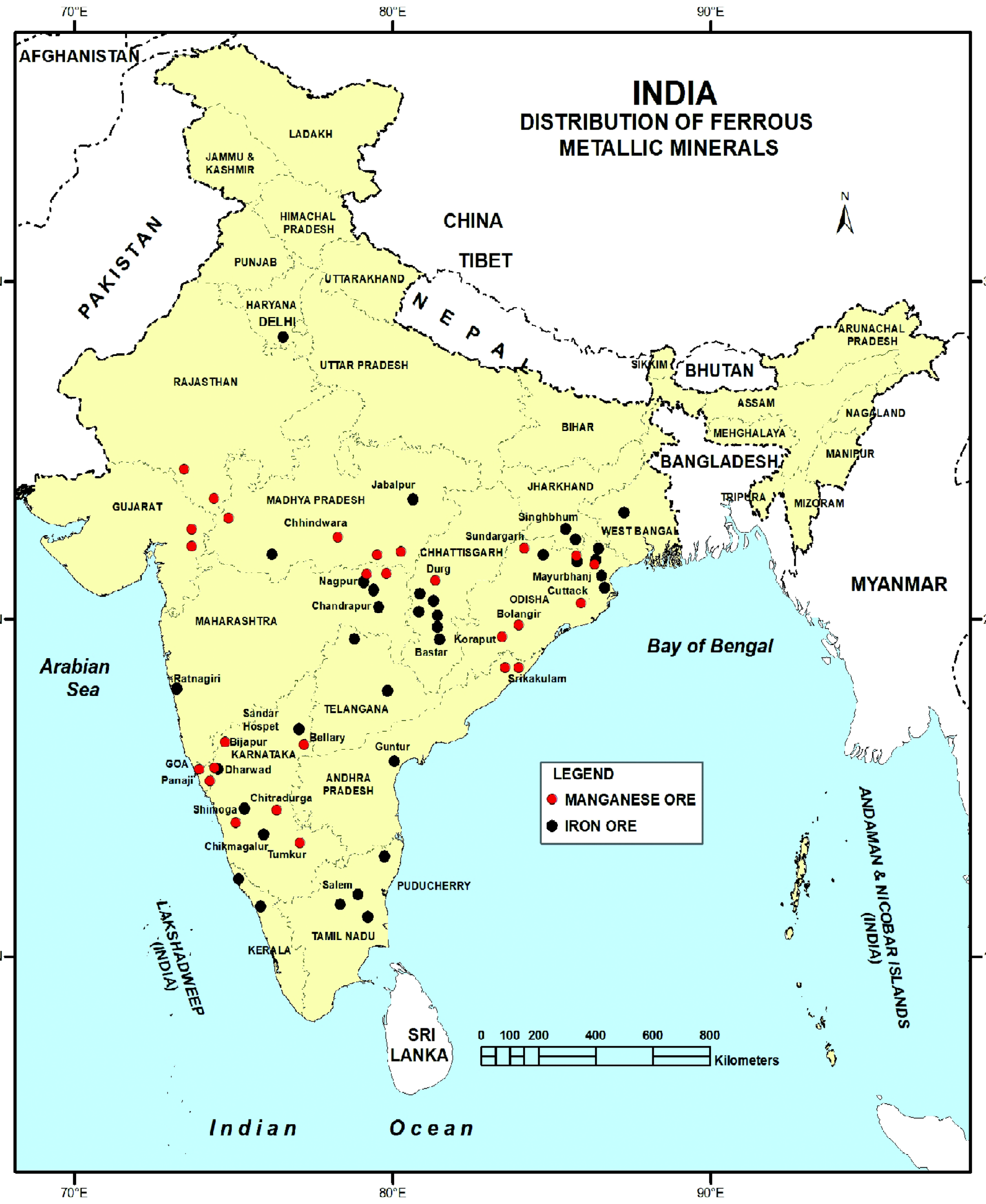


Fig. 18.1 INDIA : Distribution of ferrus metalic minerals

Distribution

We can find Iron ore deposits in almost every state of India. However, 96 percent of the total reserves are in Odisha, Jharkhand, Chhattisgarh, Karnataka and Goa. These states also account for 96 percent of the total production of iron ore in the country. About 3 percent of the country's total production comes from Tamil Nadu, Maharashtra and Andhra Pradesh.

Odisha and Jharkhand together possess about 50 percent of India's reserves of high-grade iron ore. The principal deposits are located in Sundargarh, Mayurbhanj and Keonjhar districts of Odisha and Singhbhum district of Jharkhand. The other important states are - Assam, Bihar, Madhya Pradesh, Meghalaya, Rajasthan and Uttar Pradesh.

ii. **Manganese Ore:** India ranks seventh (in 2019) in the production of manganese ore in the world contributing 5.13% of world's total production. A large part of the total production of India exported.

Manganese ore is an important ingredient for the manufacture of iron and steel. It is also extensively used for manufacturing dry batteries, in photography, leather and match industries. About 85 percent of total manganese consumption in India is used by metallurgical industries.

Distribution

The important areas of production are in Odisha, Madhya Pradesh, Maharashtra, Karnataka and Andhra Pradesh. Over 78 percent of total reserves of manganese ore of India occur in a belt stretching from Nagpur and Bhandara districts of Maharashtra to Balaghat and Chhindwara district of Madhya Pradesh. But these two states contribute only 12 and 14 percent of total production respectively. The remaining 22 percent of reserves are distributed in Odisha, Karnataka, Gujarat, Rajasthan, Goa and Andhra Pradesh.

b. **Non-Ferrous Metallic Minerals:** The second category of minerals are Non ferrous minerals. These minerals do not contain iron. Gold, silver, copper, tin, lead, zinc etc. are some of the important non ferrous minerals. These metallic minerals are highly important in day to day life. However, India is quite deficient in such minerals

i. **Bauxite:** Bauxite is a non-ferrous metallic mineral. It is the ore from which aluminium metal is produced. India's resources of bauxite are sufficient to keep the country self-reliant. Aluminium extracted from the ore is used in making aeroplanes, electrical appliances and goods, household fittings, utensils etc. Bauxite is also used for manufacturing of white colour cement and certain chemicals. India's resources of bauxite of all grades have been estimated at 3,897 million tonnes (in 2015).

Table 18.2 Production of Bauxite in India

Year	Production (in thousand tonnes)
1951	68.1
1961	475.9
1971	1,517.1
1981	1,954.6

Notes

1991	4,977.0
2004-2005	11598.0
2019-20*	21,824.0

* - As per Annual Report- 2021-22, Ministry of Mines, Govt. of India

Distribution

Bauxite has a wide occurrence in the country. Major reserves occur in Jharkhand, Maharashtra, Madhya Pradesh, Chhattisgarh, Gujarat, Karnataka, Tamil Nadu, Goa and Uttar Pradesh.

India exports bauxite to a number of countries. The leading importer of Indian bauxite is Italy, followed by the U.K., Germany and Japan.

Fig. 18.2 INDIA : Distribution of Bauxite ore

B. Non-metallic Minerals

India is also rich in non-metallic minerals as many are found in India. However, only a few of these are commercially important. Some of the important non-metallic minerals are limestone, dolomite, mica, kyanite, sillimanite, gypsum and phosphate. These minerals are used in a variety of industries such as cement, fertilisers and electrical goods. In this lesson we will be studying about mica and limestone. Lets learn about some of the important non-metallic minerals:

i. **Mica :** India is the leading producer in sheet mica. It was one of the indispensable minerals used in electrical and electronic industries till recently. As estimated in 2015, the total resource of mica in the country is 635,302 tonnes.

Distribution

Although mica is widely distributed, workable deposits occur in three principle belts. Andhra Pradesh has the highest share of mica resources with 40% followed by Rajasthan, Odisha, Maharashtra, Bihar, Jharkhand and Telangana.

ii. **Limestone:** Limestone is useful in a wide range of industries. Approximately two thirds of the country's total consumption is used in the cement industry. Iron and steel industry, chemical industries, sugar, paper, fertilisers and ferromanganese industries are some of the other areas where it is used in large quantities. Limestone with high silica content is preferred in the cement industry. It is estimated (in 2015) that India has 203,225 million tonnes of limestone resources.

Distribution

The major producing states are Madhya Pradesh, Karnataka, Chhattisgarh, Andhra Pradesh, Telangana, Gujarat, Rajasthan, Tamil Nadu, Maharashtra, Himachal Pradesh, Odisha, Bihar, Jharkhand, Uttarakhand and Uttar Pradesh. The remaining part comes from Assam, Haryana, Jammu & Kashmir, Kerala, and Meghalaya.

INTEXT QUESTIONS 18.2

1. Which of the following is not a belt of mineral distribution in India?

   a. North eastern plateaus

   b. South-western plateaus

   c. North-western region

   d. South-eastern plateaus

2. Which of the following mineral is a non ferrous mineral-

   a. Manganese,

   b. Bauxite

   c. Chromite

   d. Pyrite

3. The ore termed as 'red ore' is-

   a. Haematite

   b. Pyrite

   c. Magnetite

   d. Limonite

4. What was India's rank in producing iron ore in the world?

   a. 1st

   b. 7th

   c. 3rd

   d. 4th

18.3 ENERGY RESOURCES

Optimum availability of energy resources is essential for economic development and improving the quality of life. It is very difficult to imagine modern living without the use of energy resources. Day by day the consumption of energy has been increasing. It is available in various forms in India.

There are several sources of energy. They are classified in different ways. One way of classification is based on their longevity. For instance mineral resources such as coal, petroleum etc are all non-renewable or exhaustible resources while water, the sun, wind, tides, hot springs and biomass are all inexhaustible or renewable sources of energy.

Yet another classification of energy is based on conventional and non- conventional sources. The former includes coal, petroleum, natural gas etc. The non-conventional sources of energy include sun, wind, water, tides, hot springs and biomass. Let's learn about some forms of energy resources in India.

A. Conventional Source of Energy

Conventional energy resources includes coal, petroleum, natural gas etc

a. Coal: In India, coal is the primary source of commercial energy. It is used as fuel in industries, thermal power stations and also for domestic purposes in some parts of the country. It is also used as a raw material in chemical and fertiliser industries and in the production of thousands of items of daily use.

The Geological Survey of India has estimated the total coal reserves of the country stand at 326.496 billion tonnes. The total production of coal was 729.10 million tonnes in 2019-20. A large part of the Indian coal reserves are of rather poor quality. Therefore, coking coal is imported to meet our requirements. In India, emphasis is being laid on setting thermal and super thermal power stations on or near the coal fields and electricity generated is supplied to far off places through transmission lines. At one time Indian railways were the largest consumer of coal. Since they have switched on to the use of diesel and electricity they are no more the direct consumer of coal.

Distribution

Coal in India occurs in two important types of coal fields. They are the Gondwana coal fields and Tertiary coal fields. Out of the total coal reserves and production in India, Gondwna coal fields contribute 98% and the rest 2% is produced by tertiary coal fields. The Gondwana coalfields are located in the sedimentary rock systems of the lower Gondwana Age. They are distributed chiefly in the river valleys of the Damodar (Jharkhand - West Bengal); the Son (Madhya Pradesh-Chhattisgarh); the Mahanadi (Odisha), the Godavari (Andhra Pradesh and Telangana) and the Wardha (Maharashtra). Tertiary coalfields occur in the extra-peninsular areas which include Assam, Meghalaya, Nagaland, Arunachal Pradesh, Jammu & Kashmir and Sikkim. Besides lignite or brown coal are found in coastal areas of Tamil Nadu, Gujarat and in land basins of Rajasthan.

Fig. 18.3 INDIA : Major Coal Fields

Fig. 18.4 INDIA : Major Petroleum Producing Areas

b. Petroleum: Petroleum is one of the most important minerals in our modern civilization and is called liquid gold because of its value. Our agriculture, industry and transport system depend on petroleum in several ways.

The crude petroleum is a mixture of combustible hydrocarbons in solid, liquid and gaseous forms. Petroleum products used as fuel, lubricant, material for manufacturing synthetic derivatives and chemicals required in industries. Petrol, kerosene, diesel, detergents, synthetic fibres, plastics, cosmetics etc. are important products derived from petroleum.

Distribution

Petroleum occurs in anticlines and fault traps. In India, it is found in the sedimentary rock formation. Most of such areas lie in the Assam, Gujarat and off shore areas along the western coast.

The entire production of India till today comes from the Assam belt, Gujarat- Cambay belt and Bombay High. The Assam belt extends from Dehang basin in the extreme north-east of Assam along the outer flanks of hill ranges forming the eastern border of Bhitra and Surma Valley. The Gujarat-Cambay belt extends from Mehsana (Gujarat) in the north to the continental shelf off the coast right up to Ratnagiri (Maharashtra) in the south. It covers Bombay High which is the largest producer of petroleum in the country. In Assam, the oil producing area is located in the Lakhimpur and Sibsagar districts. The oil wells are located mainly around Digboi, Naharkatiya. Sibsagar and Rudrasagar. In Gujarat, the oil producing area covers Vadodara, Broach, Kheda, Mehsana and Surat Districts. Recently petroleum reserves were discovered in the state of Rajasthan covering major areas of Bikaner, Barmer and Jaisalmer and gas has been discovered along the east coast in the Godavari and Krishna deltas. The prospective areas lie in the Bay of Bengal, which covers the coastline along the state of West Bengal, Odisha, Andhra Pradesh, Tamil Nadu and Andaman and Nicobar Islands.

Oil Refineries in India

The crude petroleum taken from oil fields needs to be refined before it can be used. Oil refining is really a big chemical engineering industry involving a complicated process. Presently, there are a total 23 oil refineries in India. Out of these 18 are in the Public Sector, 2 in the Joint Venture and 3 in the Private Sector. India is becoming a global refining hub with the capacity of 248.9 MTPA and is the fourth largest refiner in the world after the United States, China and Russia. Although the annual production shows an increasing trend, the country has to import petroleum and petroleum products to meet its requirements.

Fig. 18. 5 India: Oil Refineries

c. **Natural Gas:** Natural gas is emerging as an important source of commercial energy. Most of the time it is found in association with petroleum.. But this quantity may be increased as more and more reserves are being discovered. Production of natural gas in 2020-21 was 23,579.54 MMSCMD.

d. Atomic Minerals : Atomic energy can be produced by fission or fusion of the atoms or rather the nuclear parts of radio-active minerals like uranium thorium and radium. India possesses the world's largest reserves of monazite, the principal source of thorium and some reserves of uranium.

i. **Uranium:** In India, uranium is embedded in the igneous and metamorphic rocks in Jharkhand, Rajasthan, Andhra Pradesh and some parts of Himalaya. A substantial source of uranium deposits is also found in the monazite sands along the Kerala coasts.

The production of uranium at present is confined to the mines at Jaduguda in Singhbhum district of Jharkhand. The total reserves of uranium in the country are enough to support more than 5,000-10,000 mw of electricity generating capacity.

ii. **Thorium:** Thorium is principally obtained from monazite. The beach sands of Kerala in Palakkad and Quilon district contain the world's richest monazite deposits. It also occurs on the sands of Visakhapatnam in Andhra Pradesh.

On the basis of the availability of these resources, electricity production has been transformed in India. Let's have a look at thermal power production in India.

Thermal Power

The thermal power includes the energy generated from coal, diesel and natural gas. It is the main and largest source of power supply in the country. Presently, the installed capacity of thermal power stations is four times more than the installed capacity of hydel power. During 2022-23, India has installed generation capacity of 2,36,469 MW thermal power out of 4,11649 MW of total capacity. This is approximately 57% of the total installed capacity in India. Thermal energy has shown a rapid growth in India after the creation of the National Thermal Power Corporation (NTPC) in 1975. Presently, NTPC has 26 coal based power stations. The company has a coal based installed capacity of 51,150 MW. It also has 7 coal based joint ventures and subsidiaries with a commissioned capacity of 7,004 MW.

Super Thermal Power plants have been established mainly very close to big coal mines i.e. Singrauli (U.P.), Korba (Chhattisgarh), Ramagundam (A.P.) etc. Most of these power plants have improved their efficiency and profitability through improved plant load factor (78% against the national average of 63%) with the electrification of trunk routes railways have also set up their own super thermal power stations in the regions lying away from major coal fields. In Tamil Nadu there is a big thermal power plant at Neyveli which is fed by local lignite coal fields.

Notes

Besides coal based thermal power plants, the latest trend is to encourage diesel and natural gas based thermal power plants. Such plants can be set near the distribution or market centres. The gestation period of oil or gas based plants is generally the shortest. These plants are also found to be more efficient than coal based plants. The oil and gas pipes have to be laid for continuous supply of petroleum and natural gas for such power plants. As India has very limited resources of mineral oil and proven gas resources, it has to import these raw materials including naptha etc. from other countries.

Petroleum based power units have been set up in the remote areas of North East and Himalaya region.

Fig. 18.6 INDIA : Thermal Power Plants

Nuclear Power

India had developed the technology of generating energy from nuclear minerals such as uranium and thorium. Installation of nuclear reactors for generating power requires huge capital and sophisticated technological skills. The share of nuclear power in the total energy produced in the country is hardly 1.6%. India has a total of 6,780 MW installed generation capacity for the nuclear sector. Nuclear power is a promising source of energy for the future. It would play a complementary role when the other sources of power like coal and petroleum would be exhausted.

Nuclear power programme was initiated in the 5th decade of the last century and an apex body for decision-making regarding atomic programmes, the 'Tata Atomic Energy Commission' was incorporated in August 1948. But progress in this direction could be made only after the establishment of the Atomic Energy Institute at Trombay in 1954. Which was renamed as the 'Bhabha Atomic Research Centre' (BARC) in 1967. Consequently, the first nuclear power station with 320 MW capacity was set up at Tarapur near Mumbai in 1969. Later, atomic reactors were installed at Rawatbhata in Rajasthan, Kalpakkam and Kudankulam in Tamil Nadu, Narora in Uttar Pradesh, Kaiga in Karnataka and Kakrapar in Gujarat also have nuclear energy plants. Thus at present, nuclear energy is produced at 7 centres. Requirements of fuel and heavy water of these power reactors are fulfilled by the Nuclear Fuel Complex located at Hyderabad and heavy water plant at Vadodara.

B. Non- Conventional Source of Energy

Conventional sources of power like coal, petroleum and natural gas are likely to exhaust in the near future. Therefore, there is a need to find and develop alternative sources of power. Hydel power is also a non-conventional energy resource. However, it needs to be utilised judiciously. Sun, wind, tides, biological wastes and hot springs are such sources which can be developed as the alternative sources of power. They are called the non-conventional sources of energy. These sources of energy are renewable and pollution free. Let's discuss some important non-conventional sources of energy. Around 40% generation capacity was from non conventional sectors in 2022.

a. **Hydroelectric Power:** Development of hydroelectric power started in the last decade of the 19th century with the establishment of a hydroelectric plant for supplying electricity to Darjeeling in 1897. In 1902, another hydropower plant was established at Shivasamudram waterfall on Kaveri river in Karnataka. Later, a few plants were established in the Western Ghats to meet the requirements of Mumbai. Hydropower plants were also commissioned in Uttar Pradesh, Himachal Pradesh in the north, and Tamil Nadu and Karnataka in the south in the 1930s. Total generation capacity reached 508 MW in 1947. Massive efforts were made

to develop waterpower during the Five Year Plans and several multipurpose projects were commissioned.

India has impressive shares of hydel electricity generation capacity in total installed capacity in India. The total installed capacity of hydel power in 2022 was 46,850 MW which was approx 11.4% in total installed capacity.

In spite of being a cheaper, pollution-free and renewable source of power, the significance of hydroelectricity has declined in the post-independence period. Its share in total power generation declined from 49 percent in 1950-51 to only 11.4 percent in 2022-23. Nevertheless, hydroelectricity plays a very significant role in northern, western and southern grids.

Fig. 18.7 INDIA: Hydro Power Plants

b. **Solar energy:** The Sun is the primary source of all energy on planet earth. Sun is the most vital, abundant and direct source of energy. India lies in the tropical zone and has plenty of sunshine, for long hours of the day and has large possibilities to develop solar energy. Solar energy is tapped through the system of Solar PhotoVoltaic (SPV) cells. The thermal heating system can be used for water heating, solar cookers for cooking meals and drying food grains etc. Solar energy can be developed in almost every part of the country but more so in hot, dry and cloud free areas. Karnataka is presently tops with most installed capacity. Other important states are Rajasthan, Madhya Pradesh, Telangana, Andhra Pradesh, Tamil Nadu etc. India has 63,894 MW installed capacity sharing 15.1% of total installed capacity.

c. **Wind Energy:** Wind can be used as a source of energy in those regions where strong and constant winds blow throughout the year. Wind energy can be used for pumping water for irrigation and also for generating electricity. India has about 41,983 MW installed generation capacity in 2022-23. Tamil Nadu tops with installed capacity followed by Gujarat, Maharashtra, Karnataka and Andhra Pradesh.

d. **Bio Energy :** Biomass is also an important source of energy for the country. It is a renewable resource, widely available and carbon-neutral also. It may also be useful in generating employment in the rural areas. The sources of Biomass are biogas, rice husk, straw, cotton stalk, coconut shells, soya husk, de-oiled cakes, coffee waste, jute wastes, groundnut shells, saw dust etc. The total installed capacity was 10,210 MW in 2022-23.

e. **Tidal Energy:** Energy can also be generated from high tidal waves. Some of the important sites identified for generating tidal energy are located in the Gulf of Kachchh and Cambay in Gujarat state and the coast of Kerala.

f. **Geothermal energy:** The potential of geothermal power is very limited in India. Important sites selected for generating geothermal power are situated in Himachal Pradesh (Mani Karan) and Laddakh (Puga valley in Ladakh). Assessment of geothermal energy potentials of selected sites in Himachal Pradesh, Jammu and Kashmir, Uttarakhand, Jharkhand and Chhattisgarh is being undertaken.

INTEXT QUESTIONS 18.3

1. The river valley which is not included in Gondwana coal field-

a. Godavari b. Jhelum

Notes

c. Son d. Damodar

2. The mineral termed as 'liquid gold' -

a. Coal

b. Natural Gas

c. Petroleum

d. Thorium

3. How many oil refineries are established in India?

a. 26

b. 29

c. 23

d. 32

4. In which state Uranium is produced?

a. Rajasthan

b. Chhattisgarh

c. Jharkhand

d. Himachal Pradesh

5. The share of hydel power in total installed capacity was:

a. 15.4 %

b. 11.4 %

c. 22.0 %

d. 16.5 %

18.4 ENERGY CONSERVATION

As we learnt that many energy resources are not abundant and if we continue to extensively use them, these may be exhausted in near future. That is why the use of alternative sources of energy were explored. Even, the alternative resources of energy are non- exhaustible but still they require to be used wisely. Therefore, it's essential to use appropriate methods to conserve energy resources. Some of the ways can be adopted to conserve it:

i. Reduce; recycle and reuse are one of the most effective ways to conserve energy resources. Reducing the consumption has the direct impact on the utilisation of resources

ii. Some change in lifestyle may also reduce the uses. For example reduced use of electrical appliances, use of sunlight instead of artificial lights may reduce the demand causing reduced production.

iii. More efforts in exploring non-conventional energy resources. As a diverse country, India has a great potential to find alternative non-conventional sources of energy.

iv. A huge part of electricity is lost during transmission. By improving the efficiency of energy supply systems, it can be saved which will reduce the pressure on energy resources.

v. It can also be conserved by promoting effective public transport and public services. This will reduce individual consumption.

vi. Efforts should be made to spread awareness in schools and among the youth for the conservation of various energy resources.

As an individual we can also make some efforts to reduce the use of electricity, which finally saves precious energy resources. Some of these efforts are:

- Switching off electricity when not in use.
- Try to use public transport.
- Carpooling may also be used in place of private vehicles.
- Shut lights and television when leaving the room.
- Use the sunlight at home during day time instead of turning on the lights.
- Dry clothes in the sun instead of using the dryer during sunny days.
- Turn off the dishwasher right before the drying cycle and let the dishes air dry.
- Don't leave the refrigerator door open.
- Use compact fluorescent lights (CFLs) or other efficient bulbs.
- Cool the rooms to no less than 24°C as it will give you the most comfort.
- Use sleep mode in computer Computers instead of screensavers as it uses up to 70% less electricity.

18.5 NATIONAL ENERGY POLICY-2017

The National Energy Policy (NEP) has been drafted by the NITI Aayog in 2017. It has

extended to reforms and provisions further from the 2006 Integrated Energy Policy (IEP) to excel in the energy sector and continue the growth rapidly. There are four key objectives of National Energy Policy-

- Access at affordable prices
- Improved security and Independence
- Greater Sustainability and
- Economic Growth

Aims of National Energy Policy

- The National Energy Policy has been framed with the intention to devise a broad framework for the overall energy sector. It has talked about effective use of technology and fuel options.
- The National Energy Policy aims to electrify all the Census villages by 2018, and to achieve universal electrification with 24×7 electricity by 2022.
- The share of manufacturing in our GDP is to go up to 25% from the present level of 16%, while the Ministry of Petroleum is targeting reduction of oil imports by 10% from 2014-15 levels, both by 2022.
- NDC (Nationally Determined Contributions) targets a reduction of emissions intensity by 33 percent-35 percent by 2030 over 2005.
- Achieving a 175 GW renewable energy capacity by 2022, and share of non-fossil fuel based capacity in the electricity mix is aimed at above 40% by 2030.
- Mainstream emerging energy technologies and provide consumer energy choices.

INTEXT QUESTIONS 18.4

1. Who drafted National Energy Policy 2017?

   a. Niti Ayog

   b. NTPC

   c. BEE

   d. Ministry of Mines

2. National Energy Policy 2017 was based on -

a. Integrated Energy Policy 2003

b. Integrated Energy Policy 2002

c. Integrated Energy Policy1998

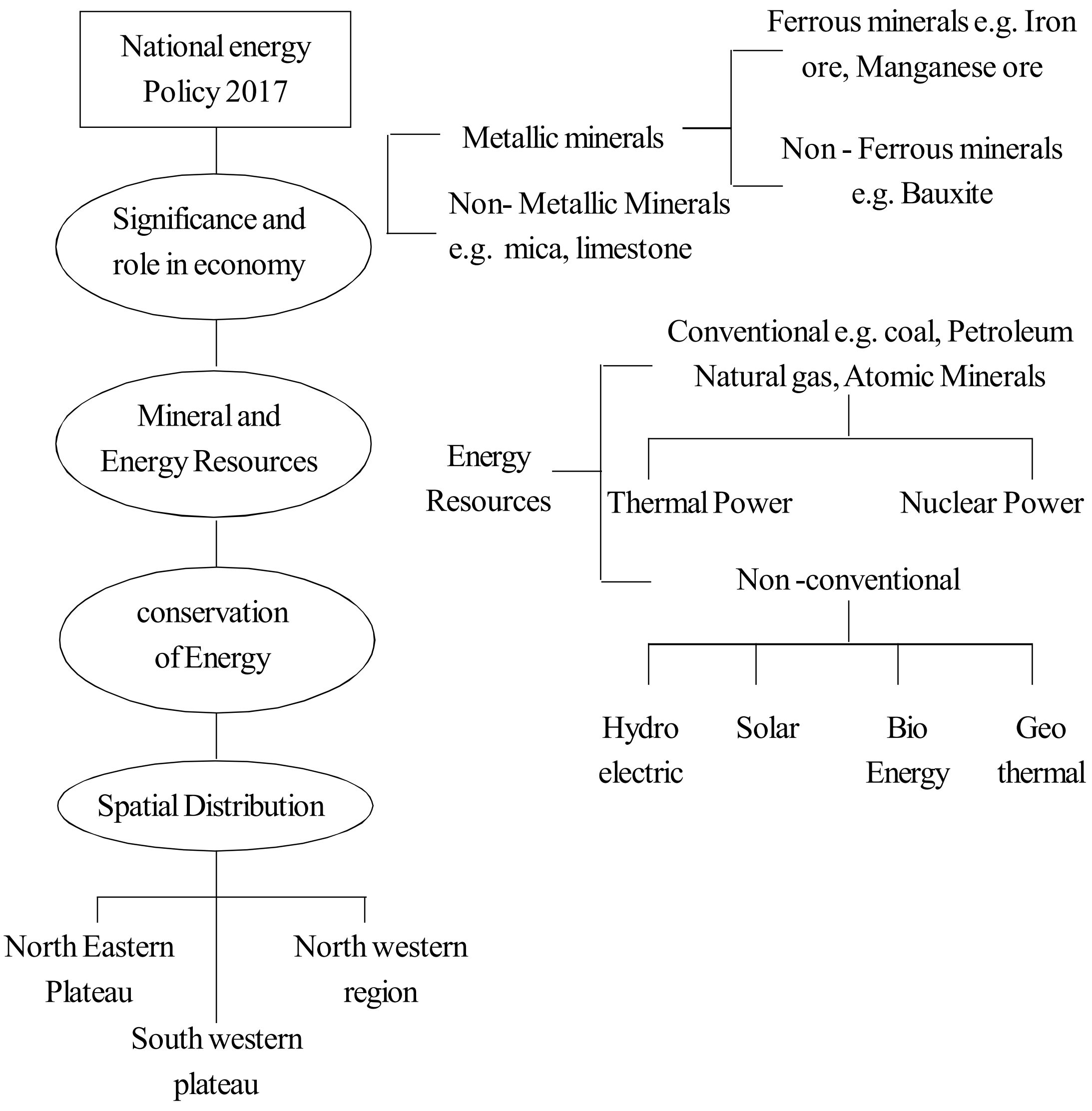
d. Integrated Energy Policy 2006

3. National Energy Policy 2017 aimed to achieve universal electrification with 24×7 electricity by:

a. 2018 b. 2019

c. 2025 d. 2022

WHAT YOU HAVE LEARNT



TERMINAL QUESTIONS

1. Why are mineral and energy resources significant for the Indian economy?
2. Describe the distribution and production of the following minerals and mineral fuels in India:
   (a) Bauxite
   (b) Iron ore
   (c) Petroleum
3. Differentiate between conventional and non-conventional energy with suitable examples.
4. Give any two reasons why we should prefer non-conventional energy resources.
5. Distinguish between wind and solar energy.
6. On an outline map of India show the following
   (i) Jharia and Raniganj coal fields.
   (ii) Ankaleswar and Digboi oil fields.
   (iii) Mathura and Panipat oil refineries.
   (iv) Talcher and Korba thermal power plants.
   (v) Kaiga and Kota atomic power plants.
   (vi) Bhakra and Nagarjuna Sagar hydro-electric plants.
7. On an outline map of India show the following
   (vii) Singhbhum iron ore fields
   (viii) Bauxite producing area of Tamil Nadu
   (ix) Tawa Valley and Neyveli coal field
   (x) Bombay High and Sibsagar oil fields.
   (xi) Bina and Tatipaka oil refineries.
   (xii) Talcher and Korba thermal power plants.

ANSWERS TO INTEXT QUESTIONS

18.1

1. c
2. b
3. a

18.2

1. d
2. b
3. a
4. d

18.3

1. b
2. c
3. c
4. c
5. b

18.4

1. a
2. d
3. d

19

MAJOR INDUSTRIES AND INDUSTRIAL COMPLEXES

Can you identify a few things in your house that don't occur naturally and are manufactured with the help of machines. Have you ever thought where these have been manufactured? Products such as clothes, utensils, paper, plastic boxes, notebooks, books, pens and pencils, etc. are manufactured in industries. Industries are the places where goods are produced or manufactured in large quantities. This sector includes mining and quarrying, manufacturing (Registered and Unregistered), gas, electricity, construction, and water supply. This is also known as the secondary sector of the economy. Many of these resources are used in industries to manufacture goods. Industries also provide employment to a large number of the population. Those engaged in agricultural activities are said to be involved in primary activities. Similarly, those engaged in manufacturing and industries are said to be engaged in secondary activities.

OUTCOMES

After studying this lesson, learner:

- highlights the role of industries in national development;
- differentiates between agro based and mineral based industries;
- describes spatial distribution of major industries and their production and
- identifies the major industrial complexes and regions.

19.1 SIGNIFICANCE AND ROLE OF INDUSTRIES IN NATIONAL DEVELOPMENT

Learners, as discussed in the previous lesson, agriculture, industries and services provide employment to the people of a country. Industries are considered as the backbone of development especially, economic development. This is because of the following reasons:

1. Manufacturing industries help in modernising agriculture which is the backbone of the Indian economy.

2. They reduce heavy dependence of people on agriculture by reducing the human burden on it by providing jobs.

3. As industries employ a large number of the population, industrial development is one of the preconditions for eradication of unemployment and poverty from our country. This philosophy was responsible for the development of public sector industries in India.

4. Industrial development in backward areas also aims at bringing down regional disparities.

5. Export of manufactured goods helps in expanding trade and commerce and inviting foreign exchange.

6. Transformation of raw material into finished goods adds value to the product and the skilled labour.

In India, industries employ around 12 percent of the total population. This sector has contributed 29.8 percent, 29.3 percent and 29.1 percent in GDP (Gross Value Added or GVA) for 2015-16, 2016-17 and 2017-18, respectively. The contribution of agriculture and related activities was 17.7 percent, 17.9 percent and 17.1 percent for the same three time periods.

DO YOU KNOW?

It is very important to mention here that the importance of agriculture is to provide the basic need of humankind i.e. food and cannot be seen just in terms of contribution to GDP. The comparative figures given here are in order to show how important the role industries play in the GDP of India.

In addition to its direct contribution to the economy, the secondary sector has a multiplier effect for job creation in the service sector. According to National Manufacturing Policy 2011, every job created in the manufacturing sector creates two-three additional jobs in related activities.In general, different amounts of labour and different types of skills are required in different industries. Some of the industries such as, textile, leather and food processing employ a larger number of labour as compared to machinery industry and are therefore, called labour intensive industries.

Industries add value to the existing goods and also to the skill of labour employed in it therefore, this sector is also considered as a transformational sector. In a country like India, where the agriculture sector is burdened with a large amount of surplus labour, the industrial sector can act as a good option for absorbing this surplus. As can be seen in Figure manufacturing and other industries have a larger share in the GDP as compared to the percentage of workforce employed in it as compared to the agricultural sector.

Notes

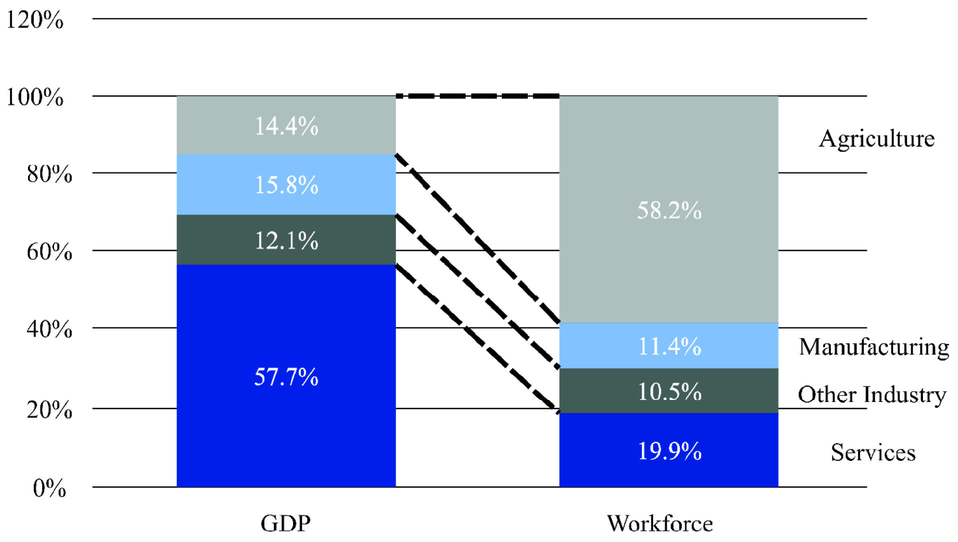


Fig. 19.1: Distribution of labour in different sectors of India and the share in GDP of economy 2017-18

Source : https://www.indiabudget.gov.in/budget, 2019-20

The demography of India having an expanding population i.e. large percentage of population in the working age-group supplements the importance of the industrial and service sector other than agriculture. The importance given to the secondary sector in several Five Year Plans and growth of this sector in the future can provide a potential for employment to a large number of the population in the coming years.

LET'S DO

Prepare a list of five countries in the world and try to find out the contribution of agriculture, manufacturing and service sector in their national economy.

In order to know how much you have understood about the industries and their importance in national development, let us go through some of the questions.

INTEXT QUESTIONS 19.1

1. What activities can be classified under secondary activities?
2. The percentage of labour force engaged in industries in India is__________.
3. Why are industries important in the Indian economy? Choose the correct answer from the given options.

i. As they are huge

ii. Because they are found everywhere

iii. As they provide employment to large number of people, modernise agriculture and reduce heavy dependence of people on agriculture

19.2 LOCATION OF INDUSTRIES

After knowing how important industries are in the national development, it is important to know whether industries can be set up anywhere or there are certain requirements for setting them up.

LET'S DO

Is there any industry near your place of residence or does anyone in the family is engaged in any industry? Talk to them and people near you and try to find out what are the factors responsible for that particular industry to be located there.

For setting up an industry it is important to keep in mind the manner in which profit can be maximised. Industries maximise the profit by reducing costs. Therefore, industries are located in the areas where they can reduce or minimise their cost of production. Some of the factors that determine location of industries are the following:

A. **Raw material -** Raw materials used in industries are the prerequisite for any type of industry and that should be available at low price or should be cheap and easy to be transported to the site of industry. Industries which are dependent on bulky, weight-loosing, perishable raw materials are located near to the source of raw materials e.g. agro-based industries and dairy industries, etc.

B. **Market -** Access to markets for selling of manufactured goods is required. Here the market means people who have a demand for these goods and have the purchasing power (ability to purchase) to buy the finished goods from the manufacturer. Remote or secluded areas with low population and lower purchasing power are considered as small markets and vice-versa.

C. **Labour supply -** Labour or human power to work in the industries is another important factor that determines the location of industries. In recent years, mechanisation of industries has reduced the importance of labour supply as a determining factor but, still there are many industries which are labour intensive or require large amounts of labour.

D. **Source of energy -** Those industries which are dependent on heavy supply of energy are located near its source. Earlier coal was the source of energy for industries therefore; industries were located near the source of coal. Later, hydroelectricity and petroleum became the source of energy.

E. **Transportation and communication facilities -** An efficient and speedy transportation is required for transferring raw material from its source to the factories. Similarly, it is required for supply of finished goods from factories to the markets. Cost of transportation is an important factor for determining the location of industries. Industries all over the world have been concentrated where easy and efficient transportation and communication facilities are available. Good communication facility is required for exchange and management of information within and outside the industry. Can you find out why there is a concentration of industries in Western Europe and East North America?

F. **Government policies -** Favourable policies of the government in compliance with industrial growth is an important factor. In India, the government has adopted regional policies and target area approaches in its various Five Year Plans to propagate industrial growth in particular regions of the country.

G. **Agglomeration economies -** Many times industries benefit from their nearness to each other. This is in the manner that either they share the infrastructure or the finished goods of one industry are used as raw materials for another. Such industries are known as agglomeration economies.

The above factors are responsible for the location of most of the industries. But, there are few industries which are not dependent on these factors and can be located anywhere or at a variety of places. This is because they are not dependent on any specific raw material and are largely dependent on component parts which can be obtained from anywhere. This gives them the liberty to get established anywhere. Such industries are known as Footloose industries. The only important factor that has been found to affect them is accessibility through roadways. Foot loose industries have generally been found to be non-polluting. Examples of Footloose industries are, mobile manufacturing industry, computer chip producing industries, etc. Let us now try to find out how much you have understood about the factors affecting the location of industries.

INTEXT QUESTIONS 19.2

1. Raw material, Market, Labour supply, Source of energy, Transportation and communication facilities, Government policies & Agglomeration economies are the factors responsible for ____________________?

2. If there is perishable raw material then where do you think that particular industry will be located?

3. Industrial units benefit each other from ______________________________.

4. Industries are based on cost maximisation or profit maximisation? Choose the correct option.

Notes

19.3 TYPES OF INDUSTRIES

In the previous sections we talked about various goods produced in industries. What do you think are all industries the same? All industries are not the same. They utilise different raw materials and manufacture different types of goods and in different quantities. In this manner, industries can be of different types depending upon various bases. Table 19.1 gives an idea about the classification of industries.

Table-19.1: Classification of industries

Sl.No.	Criteria	Types of Industries	Main characteristics	Examples
1.	Sources of Raw Material	(i) Agro-based Industries	Agricultural products used as raw materials	Cotton textile, jute, sugar and paper industry
		(ii) Mineral based Industries	Minerals are used as raw materials	Iron and steel, chemical and cement industry
2.	Ownership	(i) Public Sector	Owned and managed by Government	Bokaro iron and steel plant, Chittaranjan locomotive works.
		(ii) Private Sector	Owned and managed by an individual or a group as a company	Tata Iron and Steel J.K. cement industry Appolo Tyres.
		(iii) Joint Sector	Owned jointly by public and private sectors	Maruti Udyog
		(iv) Cooperative Sector	Owned by cooperative society of raw material producers	Sugar industry in Maharashtra, Amul (Gujarat) and IFFCO (Kandla)
3.	Function or Role	(i) Basic Industry	Finished products of basic industry are used as raw material for other industries	Iron and Steel and petro-chemical industries.
		(ii) Consumer Goods Industry	Finished products of this industry are directly used by individuals.	Toothpaste, soap, sugar industry
4.	Size of Industry	(i) Large Scale Industry	Huge investment, heavy machinery, large number of workers, large factory, 24 hour's operation.	Iron and steel, oil refineries,
		(ii) Small Scale Industries	Small investment, small factory, few factory workers	cycles, electrical goods industry
		(iii) Rural and Cottage Industries	owned by family members, small machine at homes	Jewellery, handicrafts, handlooms, art work
5.	Weight of Raw Materials and Finished Products	(i) Heavy Industries	Both raw material and finished products are heavy and bulky, high transport cost	Iron and steel, BHEL (Hardwar): heavy electrical like generator.
		(ii) Light Industries	Both raw material and finished products are light in weight, low transport cost.	Watches, readymade garments, toys, fountain pens.

INTEXT QUESTIONS 19.3

1. What are the five criteria based on which industries can be classified?
2. Cosmetics is a ________________________ industry.
3. Industries owned and managed by Government are known as ________________ and those owned and managed by an individual or a group as a company are known as ____________________.

LET'S DO

Have you ever thought in what kind of industry the paapad or market pickles are manufactures in, small-scale industry or large-scale industry? Try to find out.

19.4 AGRO-BASED INDUSTRIES

As you have read earlier that like manufacturing or industry, agriculture is also an integral sector of the Indian economy. Both these sectors complement and supplement each other in boosting the national economy. Agricultural products are used in industries as raw materials to produce various goods whereas, industries provide agricultural tools and fertilisers, etc. for growing crops and for making processed items like jams and jellies, etc.

Amul

The story of Amul started more than 70 yrs. ago in a small town of Gujarat, India. The exploitative trade practices followed by the local trade cartel triggered off the cooperative movement. When people approached Shri Sardar Vallabhbhai Patel for a solution, he advised them to get rid of the middlemen and form their own co-operative for procurement, processing and marketing. With the inspiration of Sardar Patel and under the guidance of Morarji Desai and Tribhuvandas Patel, farmers formed their own cooperative in 1946. This was known as Kaira District Co-operative Milk Producers Union Ltd. It began with just two village dairy co-operative societies and 247 lites of milk. Now this dairy is known as Amul Dairy. Dr. Verghese Kurien was appointed as the Chairman of the co-operative.

The approach of Amul Dairy formed the basis of the National dairy Development Policy.

Source - https://www.amul.com/m/about-us

Like many other industries in India, there are two important agro-based industries that play a major role in the Indian economy. These are: Sugar and Cotton industries. Let us try to know

Notes

more about these industries.

a. **Sugar industry -** Sweet dishes and chocolates are loved by all. Festivals are awaited by all of us so that we can relish sweets. Even milk, tea and coffee taken every day have sugar in it. Gur is also used in many households everyday as a sweetener. It also holds a special place in some of our festivals and religious rituals. Do you know, India stands second in the world in producing sugar and first place in the production of gur and khandsari. The raw material used in the sugar industry is sugarcane which is a bulky raw material. The amount of sucrose present in sugarcane gets reduced during transportation. Therefore, the sugar mills to churn out sugarcane juice from sugarcane and to produce sugar, gur and khandsari are generally located near the sugarcane fields or where the raw material is produced.

? DO YOU KNOW?

During Makar Sankranti also known as, Pongal, Suggi Habba, Pongal, Uttarayan, Maghi and Bihu in different parts of India gur is used as one of the important ingredients for performing rituals. For example, in parts of East India yoghurt, chuda or poha is eaten with gur; during Ellu Birodhu in Karnataka bella or gur is used; Chikkis and laddoos made of til and gur are prepared all over North India, appalu is prepared in Andhra Pradesh and Telangana; Gulachipoli/puranpoliis prepared in Maharashtra and likewise.

Distribution- Have you ever visited a place where you have seen sugarcane fields? Can you recall and list down some of the places and states producing sugarcane? Now, look at the map given below showing distribution of sugar mills in India.

Fig. 19.2 Sugarcane

Fig. 19.3: Distribution of Sugarcane mills in India

Factors responsible for distribution of sugar industry- As you know sugarcane is one of the important cash crops of India. The production of sugarcane has grown dramatically over the past several years. Sugarcane growing area in India may be broadly classified into two agro-climate regions: i) Sub-Tropical region comprising Uttar Pradesh, Bihar, Punjab and Haryana ii) Tropical region comprising Maharashtra, Gujarat, Tamil Nadu, Andhra Pradesh

and Karnataka. Since sugarcane is a perishable item and the sucrose content is lost after sometime, therefore, sugar industries are located near to the sources of sugarcane fields in these regions.

Sugarcane industry was initially set up in the subtropical region of India. Till 1950's - 90% of area under sugarcane was in this region. With the commencement of the planning process, sugarcane found its route in tropical areas. Sugarcane being a tropical crop finds favourable agro-climatic conditions for its growth in this region - i.e. higher yields. Growth after 1950's was more in this region and by 1994-95 the subtropical region sugarcane area was 65% and cane production was 55% of the total cane produced.

The recent trends show that the tropical region is already developed and reached near saturation level. This is because the biggest state in this region-Maharashtra faces an acute problem of lack of water which affects cultivation of sugarcane. The subtropical belt, with fertile land, high water table and irrigation, appears to be the area for future growth.

Production- Sugar industry usually experiences over-production for 3-4 years followed by low production for a year or two. The sugarcane crop is sturdy and can withstand fluctuations in weather. Compared to many other crops, cane farmers have to put in little effort by way of inputs and human hours in growing their crops and therefore, it is often considered the 'lazy crop'.

DO YOU KNOW?

Did you know, the history of sugar and sugarcane in India goes back to several thousand years B.C? Old scriptures of India contain some legends depicting the origin of sugarcane. It is believed that sometimes in 4/6th century art of sugar making was discovered but, the method of producing sugar was crude. Cane was cut in pieces, crushed under heavy weight and the juice thus obtained was boiled and stirred, till it turned solids. Solids of uneven shape and size were called Sarkaran, a Sanskrit term of 'gravel'. Modern word 'sugar' is derived from the word Sarkara. Thus, it could be rightly said that India has been the original home for sugarcane as well as sugar manufacture.

Before the mid 1920s, India imported sugar to fulfil its demands. The number of sugar mills sprang up in UP and Bihar during the 1920s. By 1930-31, there were 29 sugar factories producing 1,00,000 MT of sugar. Sugar industry found adverse competition from Japanese sugar which was ruling the Indian market. Details of the number of sugar mills, production of sugarcane, etc. from 2015-16 to 2020-21 can be seen in the following table.

Table- 19.2: Details of number of sugar mills, production of sugarcane, etc. from 2015-16 to 2020-21

Particulars	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**
No. of factories in operation	526	493	525	532	461	506
Cane average (000 HA)	5284	4945	5042	5502	4841	5288
Sugarcane Production (Lakh tons)	3369	3036	4110	4142	3440	4018
Molasses Production (000 tons)	10873	9026	14063	13788	11526	14906

According to the Indian Sugar Mills Association (ISMA), the opening stock at the start of the 2021-22 sugar season from October was anticipated to be nearly 8.7 million tonnes.

b. Cotton industry or Cotton textile industry: Cotton industry has been an important part of Indian history. We all know Mahatma Gandhi used to spin cotton yarn out of Charkha. Even before independence cotton was produced through hand spinning tools and through handloom. Later, power-looms came which gave a setback to the existing hand spinning and handloom techniques. Many Hindi movies have shown the difficult situations through which the former went through. Do you know where the first mill was established in India? It was in Mumbai in 1854. This was because the cotton growing belt was located in Gujarat and Maharashtra.

Distribution-You must have read about the requirements for growing cotton in the module on agriculture. Can you recall a few of them? Apart from the climatic and soil conditions required for growing cotton crops, this region of India had a market, transportation facilities including port facility and labour supply, etc. All these conditions favoured establishment of the cotton textile industry in this region.

Cotton industry is closely linked with agriculture as it is an agro-based industry using cotton as a raw material. It is also a good absorber of labour in the manner that from picking of cotton pods from the plant to ginning and weaving, etc. requires labour. The industry also supports other industries like, chemicals, dyes, packaging material, machines and fashion.

Presently, cotton textile industries are located mostly in western India: Gujarat, Maharashtra;

western part of Madhya Pradesh; Tamil Nadu, West Bengal and Uttar Pradesh. By looking at the map try to recall and relate the climatic and other requirements of growing cotton and establishing the cotton industry. The production of yarns etc. is done in a large number of small units catering to local markets as well as in large factories with modern equipment.

Fig. 19.4: Centre of textile industries in India

Notes

Factors responsible for distribution- Maharashtra is the leading producer of cotton textile in the country. Mumbai has been the major centre of textile mills. About a half of the Cotton textile mills are still located in Mumbai alone. Because of this reason, it is also called as 'Cottonpolis' of India. Sholapur, Kolhapur, Nagpur, Pune, Aurangabad and Jalgaon are other important centres in Maharashtra. Can you think of the reason why so many cotton textile mills are located in this region? The following are the factors for the localization of textile industry in Ahmedabad- Mumbai - Pune region.

A **Raw material -** A large amount of cotton is grown in this belt.

B **Capital -** Mumbai, Ahmedabad and Pure are the places where capital for investment is easily available.

C **Means of transport -** This region is well connected with the rest of India by roads and railways. This facilitates transportation of finished products.

D **Accessibility to the market -** Maharashtra and Gujarat have a large market to sell textile products. Developed means of transportation help in movement of textile products to other market centres and to foreign markets. Nowadays the market has become a dominant factor in determining the location of the cotton textile industry.

E **Nearness to ports -** Mumbai port facilitates the import of machinery and good quality of cotton from abroad and export of the finished products.

F **Cheap labour -** Cheap and skilled labour is easily available to this region from the surrounding areas.

G **Power supply-** Cheap and sufficient power is also available here.

Production- India exports products of the cotton industry to various countries. For example, it exports yarns to Japan, U.S.A., U.K., Russia, France, East European countries, Nepal, Singapore, Sri Lanka and African countries as well.Though significant improvement has been done in quality of yarns produced in India but, the need is to integrate the smaller units to the larger ones.

India produced 4,182 million kg.s of cotton yarn during 2018-19. Production of cotton yarn in the last few years can be seen in table.

Table- 19.3 Production of cotton yarn from 2015-16 to 2018-19

Year	Production (in million kg)
2015-16	4138
2016-17	4055

2017-18	4064
2018-19	4182

Source: http://texmin.nic.in

INTEXT QUESTIONS 19.4

1. What are the factors responsible for the location of the cotton textile industry?
2. Why are sugar industries found mostly in humid areas?

19.5 MINERAL-BASED INDUSTRIES

Apart from agro- based industries there are industries that use minerals as raw materials. These are called mineral-based industries.Can you think of any such industry?

Iron and steel industry- Iron and steel is also known as the basic industry. This is because all other industries depend on it and the products of this industry form the basis of these industries. Steel is used in manufacturing of various industrial goods, equipment, machinery, automobiles and scientific equipment, etc.

Iron and steel industry is also known as heavy industry as the raw materials used and the finished goods manufactured are heavy and bulky. The raw materials used in the iron and steel industry are iron ore, coking coal, limestone and manganese. Can you make out these characteristics of the iron and steel industry where it should be located? Find out a clue to the answer in the given box.

Distribution- The first modern steel plant in India was set up at Kulti, Bengal in 1870 and production began in 1874. Today, there are 10 major steel plants in India.

Finished products of Iron and steel industry need efficient transport network for their distribution in markets so that, consumers can use it.

By looking at the map can you identify why the steel plants are located in particular regions? Chotanagpur region has the maximum concentration of iron and steel industries in India. Make a list of the factors that are available for setting up these plants at their particular locations.

Steel industry was delicensed in 1991 and de-controlled in 1992. Steel Authority of India Ltd. (SAIL) is the authority through which public sector undertakings market their steel.

Surrounded by the existing large mother plants of Iron and Steel, a National Investment and Manufacturing Zone (NIMZ) is being developed at Kalinganagar, Odisha. Spread over 160

sq km, the zone is envisaged to become a self contained ecosystem along with residential, commercial and social amenities and will enable the potential investors for setting up value added downstream facilities. It is expected that the Kalinganagar industrial complex in Odisha can contribute 20 percent of the country's targeted 300 million tons steel capacity by 2030.

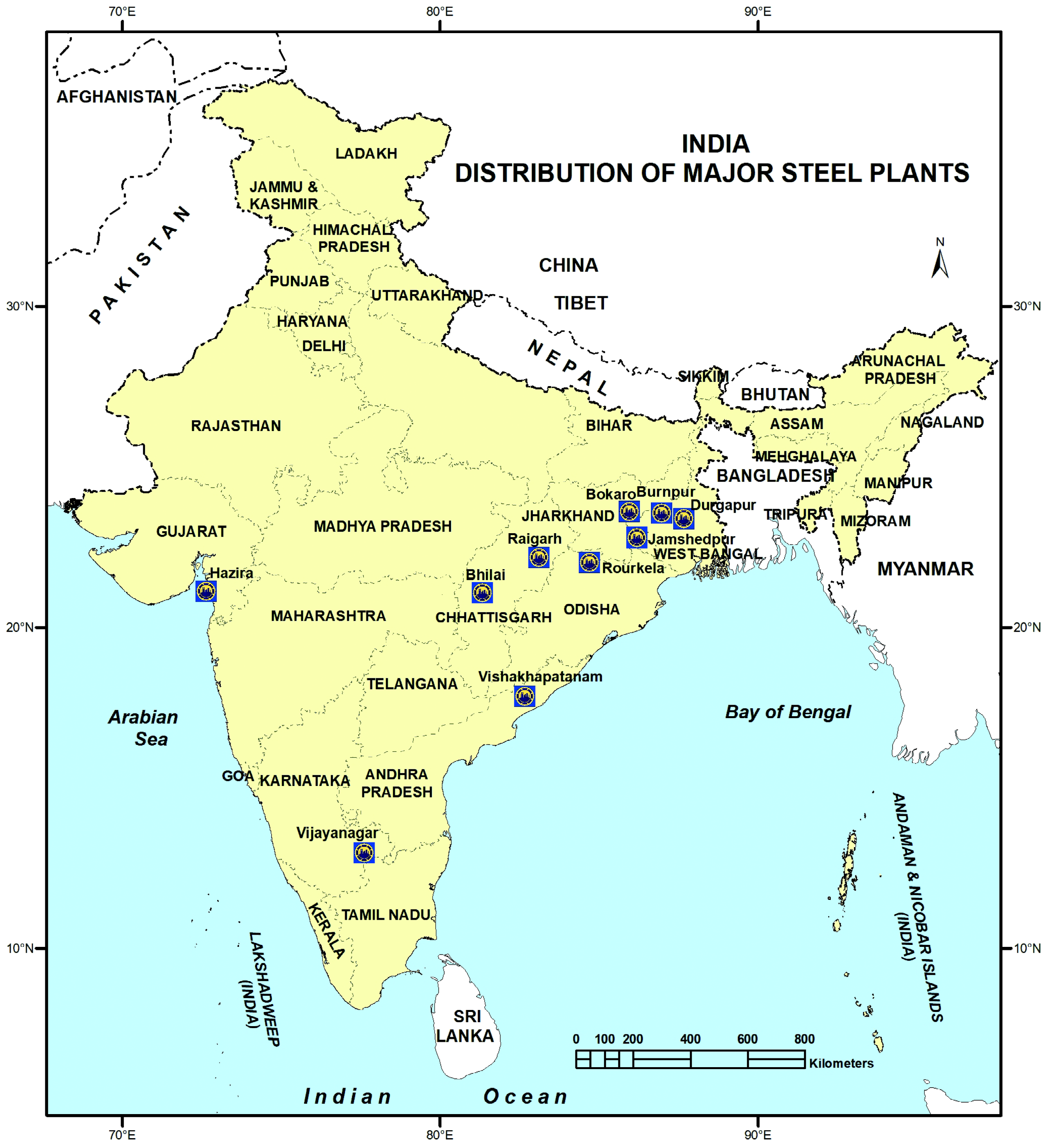


Fig 19.5: Distribution of major steel plants in India

Production- India is one of the largest producers of steel in the world and with 101.28 million tons of finished steel it ranked second in the world after China in the year 2018-19 following Table gives a brief idea of production in the iron and steel industry of India.

Table - 19.4: Production of various components of Iron and Steel Industry in India during 2018-19

S. No.	Product	Production
1	Finished steel (alloy/stainless + non alloy)	101.287 million tonnes (mt)
2	Pig Iron	6.414 mt
3	Sponge Iron	34.71 mt

Source : https://stccl.gov.in/ovcriow-steel-sector, Ministriy of Steel, govt. of India

In spite of the fact that India produces large amounts of iron and steel, it is also an importer of it. Inadequate and costly supply of coking coal, lower productivity of labour, poor infrastructure and irregular supply of adequate power are some of the factors responsible for it. Investment by the public and private sector has given a boost to the industry in the recent past but more research and development is needed. After knowing about the major agro-based industries and Iron and Steel industry, let us now try to assess our understanding with the help of a few questions.

INTEXT QUESTIONS 19.5

1. Why is iron and steel considered a basic industry? Choose the correct answer from the given options.

   i. It uses basic things

   ii. It was the first industry that was set up in India

   iii. All other industries depend on it and the products of this industry form basis to these industries

2. ____________________ has the maximum concentration of iron and steel industries in India.

3. India is ____________________ producers of steel in the world.

19.6 INDUSTRIAL REGIONS AND COMPLEXES

Now you know about various factors determining location of industries and about few important industries of India. Let us learn about various industrial regions and complexes of India.

Industries in India are not evenly located rather they are concentrated in particular regions forming complexes. Can you think of why? Yes, they tend to concentrate because of favourable conditions such as availability of raw material, market, labour, power supply and various other infrastructures at those places. Certain indicators that are used to recognize any industrial complex are the following:

i. Number of industrial units

ii. Number of industrial workers

iii. Amount of power being used for industrial purposes

iv. Total industrial output

v. Value added by manufacturing

Based on these indicators any concentration of industrial units is called an industrial complex. The regions having concentration of industries or complexes are known as industrial regions. India has several major and minor industrial regions and complexes as given in Table - 19.4. As it can be seen in the map, the major industrial regions are located mainly in the areas with rich availability of mineral resources, cheap labour supply, market and other infrastructures.

Table-19.5: Classification of industrial regions of India

S. No.	**Classification of industrial regions**	**Regions**
1	Major (8 regions)	1. Mumbai-Pune region 2. Hugli region 3. Bengaluru-Tamil Nadu region 4. Gujarat region 5. Chotanagpur region 6. Vishakhapatnam-Guntur region 7. Gurugram-Delhi-Meerut region 8. Kollam-Thiruvananthapuram region
2	Minor (13 regions)	1. Ambala-Amritsar region 2. Saharanpur-Muzaffarnagar-Bijnor region 3. Indore-Dewas-Ujjain region 4. Jaipur-Ajmer region 5. Kolhapur-South Kannada region 6. Northern Malabar region 7. Middle Malabar region 8. Adilabad-Nizamabad region 9. Allahabad-Varanasi-Mirzapur region 10. Bhojpur-Munger region 11. Durg-Raipur region 12. Bilaspur-Korba region 13. Brahmaputra Valley region

Fig. 19.5 Major industrial regions of India

In order to know how much you have understood, let us try to answer a few questions.

INTEXT QUESTIONS 19.6

1. Industries concentrated in particular regions are known as ____________________.

2. Why are several industrial units located at one place?

3. How many major and minor industrial regions are present in India? Name the major industrial regions.

4. Can you identify one the most important industrial regions of India?

19.7 GOVERNMENT INITIATIVES

By now, it is clear that industries play an important role in the national economy of any country. Therefore, it is important for any government to Since independence of India, there have been several initiatives taken up by the government of India for growth of industries and to enhance industrial production especially from the Second Five Year Plan (1956-61). In the recent past also the Government of India has taken several initiatives in order to promote a healthy environment for the growth of the manufacturing sector in the country.

Let's discucc Some of these initiatives.

Skill India campaign was launched by the Prime Minister of India, on 15 July, 2015 to train over 40 crore people in India in different skills by the year 2022. Various initiatives under this campaign are:

- National Skill Development Mission
- National Policy for Skill Development and Entrepreneurship, 2015
- Pradhan Mantri Kaushal Vikas Yojana (PMKVY)
- Skill Loan scheme
- Rural India Skill

For an example, a brief of Pradhan Mantri Kaushal Vikas Yojana (PMKVY) has been discussed here. PMKVYis the flagship scheme of the Ministry of Skill Development & Entrepreneurship (MSDE) implemented by National Skill Development Corporation. The objective of this Skill Certification Scheme is to enable a large number of Indian youth to take up industry-relevant skill training that will help them in securing a better livelihood. During PMKVY 1.0, 19.85 lakh candidates were trained, out of which 2.62 lakh (13.23 per cent) got placements. PMKVY 2.0 (2016-2020) was launched in October 2016 and by June 2019 about 52.12 lakh candidates have received training and about 57% of them reported placement

? DO YOU KNOW?

National Manufacturing Policy was launched in 2011, which aims to create to 100 million jobs in the manufacturing sector and increase the share of manufacturing in GDP to 25 per cent by 2022.

Startup India is another flagship initiative of the Government of India which was launched in

Notes

2016, to build a strong ecosystem that is conducive for the growth of startup businesses, to drive sustainable economic growth and generate large-scale employment opportunities. This initiative aims to empower startups to grow through innovation and design.It aims to contribute to the vision of transforming India into a country of job creators instead of job seekers.

Several other measures at the policy level have been taken by the government in recent times in order to support and to have a robust growth of the manufacturing sector of India.

LET'S DO

Try to identify two startup industries of your state. Try to find out the factors behind these startups coming up in your state.

INTEXT QUESTIONS 19.7

1. Why has the government taken up steps to boost industries in India? Choose the correct answer.

   i. For growth of industries

   ii. To enhance industrial production

   iii. Both i) and ii)

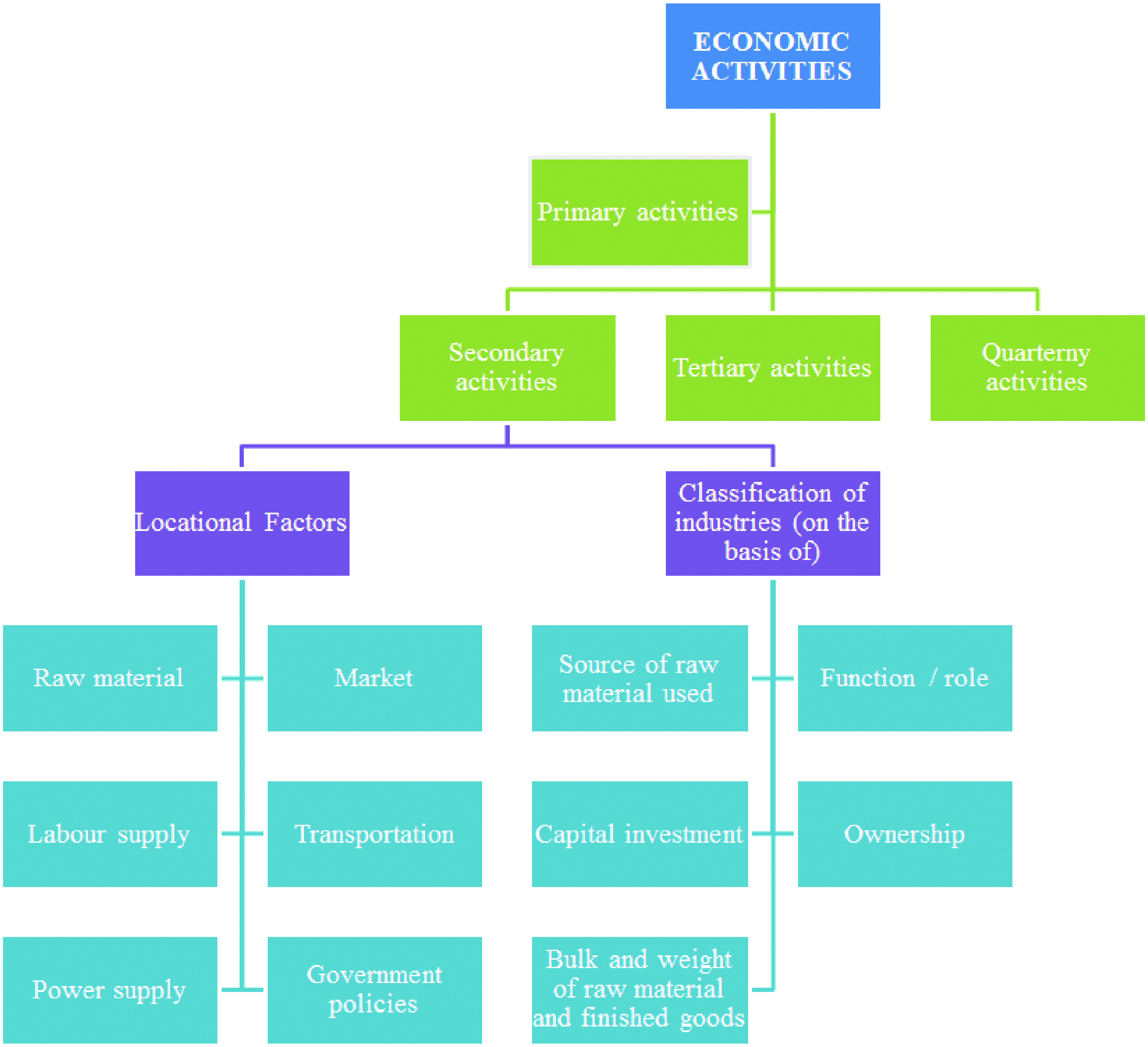
   iv. To counter agricultural growth

2. The first major effort done by the government to support industries in India was during____________________.

3. Name the two major recent government initiatives in India in order to support industrial growth.

4. What is the idea behind the launch of the Skill India programme?

WHAT YOU HAVE LEARNT



TERMINAL QUESTIONS

1. If agriculture and related activities are classified under primary activities, what are secondary activities classified under?
2. In what manner industries contribute to the national economy of India?
3. Match the following:

Aluminium smelting	Agro-based industry
Amul dairy industry	Consumer industry
Sugar industry	Small-scale industry
Soap industry	Cooperative industry
Paapad making industry	Mineral-based industry Heavy industry

4. Mobile making industry can be classified under which type of industry? What are the characteristics of these industries?
5. Certain regions of India have a concentration of industrial units. Identify the reasons behind this spatial pattern.
6. Location of specific industries has specific factors responsible for their location. What are these? Give examples in support of your answer.

ANSWERS TO INTEXT QUESTIONS

19.1

1. Mining & quarrying, manufacturing (Registered & Unregistered), gas, electricity, construction, and water supply
2. 12 percent
3. (iii)

19.2

1. Location of industries
2. Near to the source of raw material
3. Agglomeration economies
4. Profit maximisation

19.3

1. Source of raw material, ownership, function, size of industry, weight of raw material and finished products. (Any five)
2. Consumer goods industry
3. Public sector and private sector

19.4

1. Raw material, Capital, Means of transport, Accessibility to the market, Nearness to ports, Cheap labour and Power supply
2. As sugarcane is produced in humid areas

19.5

1. (iii)
2. Chotanagpur region
3. One of the largest

19.6

1. Industrial complexes
2. They benefit from each other
3. 8 major and 13 minor
4. Mumbai-Pune region, Hugli region, Bengaluru-Tamil Nadu region, Gujarat region, Chotanagpur region, Vishakhapatnam-Guntur region, Gurugram-Delhi-Meerut region, Kollam-Thiruvananthapuram region (Any of these)

Notes

19.7

1. (iii)
2. Second Five Year Plan
3. Skill India campaign, Pradhan Mantri Kaushal Vikas Yojana (PMKVY), Startup India (Any two)
4. To train over 40 crore people in India in different skills by the year 2022

20

FOREIGN DIRECT INVESTMENT (FDI), TRANSPORT, COMMUNICATION AND TRADE

In previous lessons, you have learnt about the richness of resources in our country and its agricultural and industrial development. The availability of such resources and their optimum use makes our standard of living high. The growth and development of a country is also impacted by the availability of financial resources, knowledge, technology and skills. Optimum availability of these things provide an appropriate atmosphere to grow industry resulting in the development of a country. Foreign Direct Investment (FDI) provides these essential elements of industry. Transport, communication and trade are an important aspect of the development of a country. They facilitate agriculture and industry to grow to their fullest potential. Transport carries the people and goods to different places. Communication is the process of receiving and sending messages between two persons or agencies located at different places. Trade involves exchange of goods among people living in different regions or countries of the world. It plays a vital role in accelerating the progress of agriculture and industry of a country.

In this lesson, you will study the significance of the FDI, importance of transport and communication and their distribution. In trade you will know its volume and direction.

OUTCOMES

After studying this lesson, learner:

- explains the role of FDI in the development over the years;
- identifies the different modes of transport and their development;
- traces out the role of ICT in development of India and
- describes the changing patterns of import and export.

20.1 MEANING AND SIGNIFICANCE OF FOREIGN DIRECT INVESTMENT (FDI)

According to the IMF, 'Foreign Direct Investment (FDI) is the category of international investment that reflects the objective of obtaining a lasting interest by a resident entity in one economy in an enterprise resident in another economy'. The 'Reserve Bank of India (RBI)' has also defined it as 'the investment through capital instruments by a person resident outside India (a) in an unlisted Indian company; or (b) in 10 percent or more of the post issue paid-up equity capital on a fully diluted basis of a listed Indian company'. It is an investment made by an individual or an organisation of a country into a business established in another country. This investment doesn't include money only but also includes new knowledge, technology, skills and employment. For the growth of a country it is important for the continuous growth of businesses and industries. An industry requires optimum finance for availing latest technologies, raw materials, equipment, human resources and infrastructure. In the lack of money, it becomes difficult for an industry or business to survive for a longer period. Sometimes, an industry may not be able to receive finances locally. In such cases, money received through FDI may help to provide optimum money, technology and infrastructure to innovate and grow. Often it is perceived that FDI is a channel of progress and development because it provides financial resources and technology.

The liberalisation in FDI by the Government of India was initiated during 1980-91. It began with the Industrial Policy Statements of 1980 and 1982. Later the Technology Policy Statement in 1983 also continued the process. During this period considerable degrees of trade liberalisation were also experienced. This was in the area of reductions in tariffs and the shifting of many import items under open general licence (OGL) category. However, in the beginning of 1990s, the FDI was accepted and promoted as a preferred way for financial resources over loans and other types of finance as the Foreign direct investment (FDI) in India was introduced in 1991 under the Foreign Exchange Management Act (FEMA). FDI was considered as an effective tool to bring new foreign technology which was still not available in India. Later multiple changes have been made in norms and procedures to regulate it and make it easier for doing business. Today, India is considered as an important destination for foreign direct investment.

Routes of FDI in India

There are two common routes for Foreign Direct Investments in India:

1. **The automatic route**

   Under this route an Indian company or Non-Resident does not need any prior permission from the RBI or the Government of India for investment from other countries in India. Many sectors are permitted to get 100 percent investment through the automatic route category. Such areas are agriculture and animal husbandry, airports, automobiles, construction companies, food processing etc.

2. The government route

Under this route the FDI is received after prior permission from the Government of India only. The companies interested to invest in India have to fill and submit an application form through the Foreign Investment Facilitation portal. This portal enables them to obtain single-window clearance.

Sector Specific Conditions on FDI

The FDI is governed with certain norms to monitor and regulate it. With these objectives some sectors have been identified where FDI is permitted or restricted. These sectors are:

Prohibited Sectors:

- Lottery Business including Government/private lottery, online lotteries, etc.,
- Gambling and Betting including casinos etc.,
- Chit funds,
- Nidhi company,
- Trading in Transferable Development Rights (TDRs),
- Real Estate Business or Construction of Farm Houses 'Real estate business' shall not include development of townships, construction of residential /commercial premises, roads or bridges and Real Estate Investment Trusts (REITs) registered and regulated under the SEBI (REITs) Regulations 2014,
- Manufacturing of cigars, cheroots, cigarillos and cigarettes, of tobacco or of tobacco substitutes,
- Activities/sectors not open to private sector investment e.g.(I) Atomic Energy and (II) Railway operations (other than permitted activities).

Permitted Sectors:

- Agriculture
- Agriculture and Animal Husbandry
- Plantation sector
- Mining and Petroleum and Natural Gas
- Manufacturing
- Manufacturing
- Defence
- Service sector

- Broadcasting
- Print media
- Civil aviation
- Construction development: townships, housing, built-up infrastructure
- Industrial parks
- Satellites- establishment and operation
- Telecom services
- Trading
- Railway infrastructure
- Financial Services
- Asset reconstruction companies
- Banking- private sec
- Banking- public sector
- Credit information companies (cic)
- Infrastructure company in the securities market
- Insurance
- Pension sector
- Power exchanges
- White label atm operations
- Other financial services
- Others
- Pharmaceuticals

Regional Pattern

India has witnessed a positive inflow of FDI in recent years. It attracted annual FDI inflows of approx $ 84,835 million in Financial Year 2021-22. It is estimated that the Total FDI inflows in the country in the last 22 years (April 2000 - March 2022) were $ 847 billion.

It is also observed that there are regional variations in receiving the FDI from different countries. Singapore with 27.01% of the total FDI topped the list of countries investing in India for financial year 2021-22. It was followed by the USA (17.94%), Mauritius (15.98%), the Netherlands (7.86%) and Switzerland (7.31%). There are also variations in receiving FDI in

different sectors. If we talk about the major sector receiving the FDI for financial year 2021-22, the Computer Software & Hardware sector has received the highest FDI with 24.60%. Next was Services Sector (Fin., Banking, Insurance, Non Fin/Business, Outsourcing, R&D, Courier, Tech. Testing and Analysis, Other) which received 12.13%. Other important sectors were Automobile Industry (11.89%), Trading 7.72% and Construction (Infrastructure) Activities (5.52%).

INTEXT QUESTIONS 20.1

1. The term FDI refers to-

    a. Foreign Digital Investment

    b. Foreign Direct Investment

    c. Force Direct Investment

    d. Free Digital Investment

2. Which Country has maximum shares in FDI?

    a. USA

    b. UAE

    c. Singapore

    d. Switzerland

20.2 TRANSPORTS IN INDIA

India is a vast and diverse country with long distances. It has climatic as well as physiographic diversity. A dense and efficient network of transport is essential to promote social cohesion, accelerate economic prosperity and ensure security and territorial integrity. Transport consists of three different modes - land, water and air. Each one of them has some advantages and disadvantages. They all compete with one another. More importantly they complement each other and in the process constitute a single integrated network.

While air transport is of recent origin, the other two have been as old as the nomadic man himself. The land transport comprises road and rail transport. Of the two, rail transport is relatively new. The road transport on the other hand is very handy and convenient to carry goods and passengers over relatively short distances. Water transport for passengers is now no more attractive; but it is an ideal means of transport to carry heavy and bulky goods along navigable rivers and across the oceans of the world. Air transport has become tremendously

popular for people who are called upon to urgently visit various parts of the world at a very short notice.

Transport system links areas of production with those of consumption. It facilitates the movement of goods, services and people at local, regional, national and international levels.

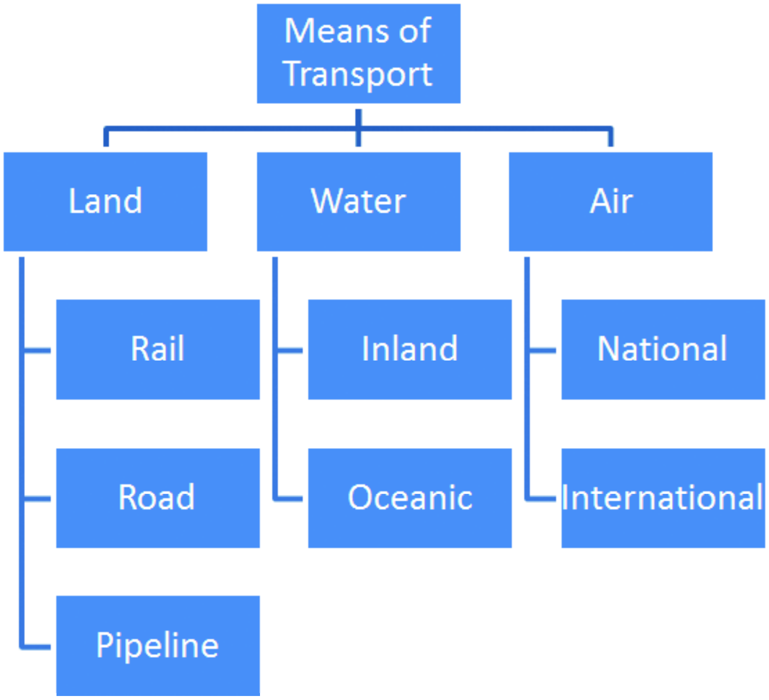


Fig. 20.1 Types of Transport

20.3 RAIL TRANSPORT

The Indian railway network is the fourth largest in the world after Russia, the U.S.A. and Canada. In a vast country like India, it has brought the people of the farthest corners of the country closer to one another. Railways are ideal for carrying goods and people over long distances. It employs the largest number of persons among the Central Government departments.

The first train steamed off in the country in 1853 from Mumbai to Thana, covering a distance of 34 km. During these years, Indian railways have grown into a vast network. The following table may give you an idea about the growth of the railway system during the post-independence era.

Table 20.1 Indian Railway- at a glance

Description	**1950-51**	**2019-20**
Total routes (in kilometre)	53,596	67,956

Notes

Electrified routes (in kilometre)	388	39,329
Number of Stations	5,976	7,325
Number of persons originating (in millions)	1,284	8,086
Passengers kilometre# (in millions)	66,517	10,50,738
Total Freight Traffic tonnes km.* originating (in millions)	93	1,212.22
Number of Steam locomotives	8,120	39
Number of Diesel locomotives	17	5,898
Number of Electric locomotives	72	6,792

Source-

- Summary sheet - Annual Report 2021-22, indianrailways.gov.in, Ministry of Railway, Govt. of India
- India, 2021, A reference annual

1 passenger-km = when one passenger travels one km.

*1 tonne km = when 1 tonne of goods is carried over one km.

You can observe from the above table that Indian railways has made tremendous progress over 75 years. In the first place the total route length has increased very slightly. However, the routes are not totally electrified but it is continuously increasing. Approximately 60% route lengths are electrified. It means over this track the traffic is far cleaner and faster. Similarly, the route length has increased only marginally but the passenger- km traffic has increased multiple times. Even the goods traffic in terms of tonne-km has increased by well over ten times. This also speaks of qualitative increase in the efficiency of the railways. This has become possible by electrification of part of the route and dieselisation of the track.

The railways have undertaken to convert metre gauge railway tracks into broad-gauge (1.68 metres) enhancing the capacity of railways to carry more goods and more passengers with an increased speed. Indian Railways also run several fast trains. Earlier there were passenger and express or mail trains, the only two categories. Now there are Super fast Expresses, Rajdhani Expresses, Shatabdi Expresses, Vande bharata, Hamsafar, Duronto, Jan shatabdi, Garib rath, Tejas, Gatiman, Double decker etc.

Let us have a glance at the regions of dense, moderate and sparse railway networks.

Notes

The Regions of Dense Network

- The northern plains and eastern coastal areas possess a dense network of railways. The level land, fertile soils, dense population and spread of industries are the reasons for this dense railway network.
- The plains of Gujarat and Saurashtra, Central Tamil Nadu and Chota Nagpur Plateau are the other regions. These regions have well developed industries.

Regions of Moderate Railway Network

- The whole of the peninsular region except Tamil Nadu and Chhotanagpur has a moderate network. The hilly and plateau terrain provides unfavourable conditions for laying railway lines.
- There are long trunk routes which connect the important industrial cities and ports. The railway lines either pass through the large gaps between hills or through the tunnels.

Regions of Sparse Railway Network

- The Himalayan mountain region, comprising Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim and Arunachal Pradesh have hardly a line here and there. The hilly terrain, rugged topography are the main reasons responsible for the very sparse network. However, now efforts are being made to develop or extend the rail network in these hilly terrain.
- The North eastern region also has a sparse railway network. All hilly states in this region are almost without a railway line. The hilly terrain, thick forest cover, heavy rainfall, low level of economy and sparse population are the main factors for the absence of railway lines.
- Desert region of western Rajasthan also has a sparse network of railways.

20.4 ROAD TRANSPORT

Road transport is one of the most ancient means of transport. It plays a significant role in carrying goods and people in all parts of the country. Particularly, the rural economy depends upon road transport. The importance of roads has increased with the advent of auto vehicles. The relative importance of roads is much more than that of railways.

Importance of road transport

- Railway transport is limited to the railway heads while the roads provide door to door services.

Notes

- Roads can negotiate higher gradients of slopes and can traverse the mountainous regions. Construction of railway lines is difficult and expensive in hilly regions.
- Road transport is flexible, reliable and quick,
- It is more suitable for carrying perishable goods like milk, fruit and vegetables.
- Its cost of construction and maintenance is far less than that of the railway.
- For short distance journeys, roads are more suitable. They supplement the railways by linking the interior areas with railway heads.
- Roads are ideal for the promotion of tourism in the country.

Surfaced and Unsurfaced Roads

Surfaced roads are the metalled roads and are made up of cement, concrete or bitumen. These are all weather roads. The total route length of roads in India till March, 2019 was 63,71,847 km. It included a surface road of 41,16,390 km. Unsurfaced roads are 'Kutcha roads made up of earth. They provide tracks for the bullock carts and link the rural areas with the urban centres. They play an important role in the development of the rural economy. During the rainy season these roads are of little use. The total length of these roads was 22,55,457 km. till march 2019.

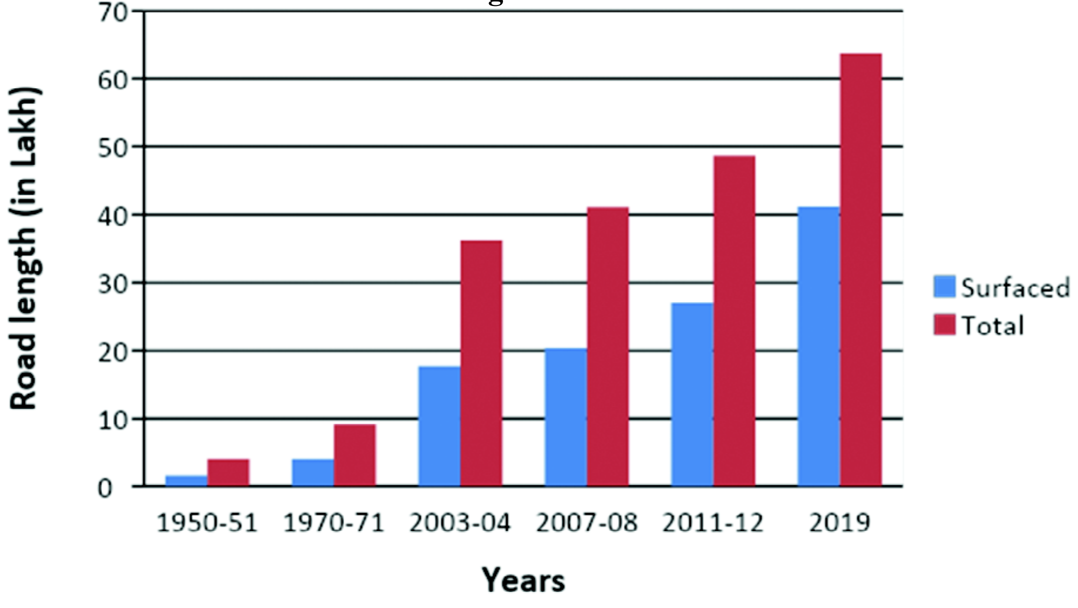


Fig. 20.2 Development of Road length in India

Development of Road Transport

There has been considerable development in the road length after independence. Route length of surfaced roads has increased from 1.571akh km. (1950-51) to 41.16 lakh km. in 2019. The length of unsurfaced roads during the same period has increased from 2.42 lakh km. to over 22.55 lakh km.

Not only has the route length of roads has increased but the number of commercial heavy vehicles, particularly the buses and trucks has also shown a tremendous increase since Independence. Vast increase in the road traffic has posed serious problems in handling it smoothly. The number of road accidents has also shown a steady increase. With increased road traffic, pollution of air has been on the rise.

Geographical Distribution of Roads

Road density refers to the average length of roads per 100 square km. area. The road density in India is increasing continuously but still comparatively low to the developed countries. High concentration of road network is found in the Northern Plains because of level land, fertile soil and high density of population. In these parts, unsurfaced roads are more common than surfaced roads. Peninsular plateau has a higher proportion of metalled roads because of the easy availability of road building materials. In the North eastern states; the road network is very sparse due to hilly terrain, thick forest cover and heavy rains causing frequent floods. Sparse population is also another important reason.

The pattern of road density is also uneven in the country. Tamil Nadu, Kerala, Punjab and Haryana have higher road density. It is because of the growth of agriculture, manufacturing industries, urbanisation and dense population. Karnataka and Maharashtra also fall in this category, the reason behind this is concentration of industries and urbanisation.

The states of Karnataka, Maharashtra, Andhra Pradesh and Telangana have moderate density of roads. In Rajasthan, Madhya Pradesh, Bihar, Jharkhand and Chhattisgarh, the density of roads is comparatively low.

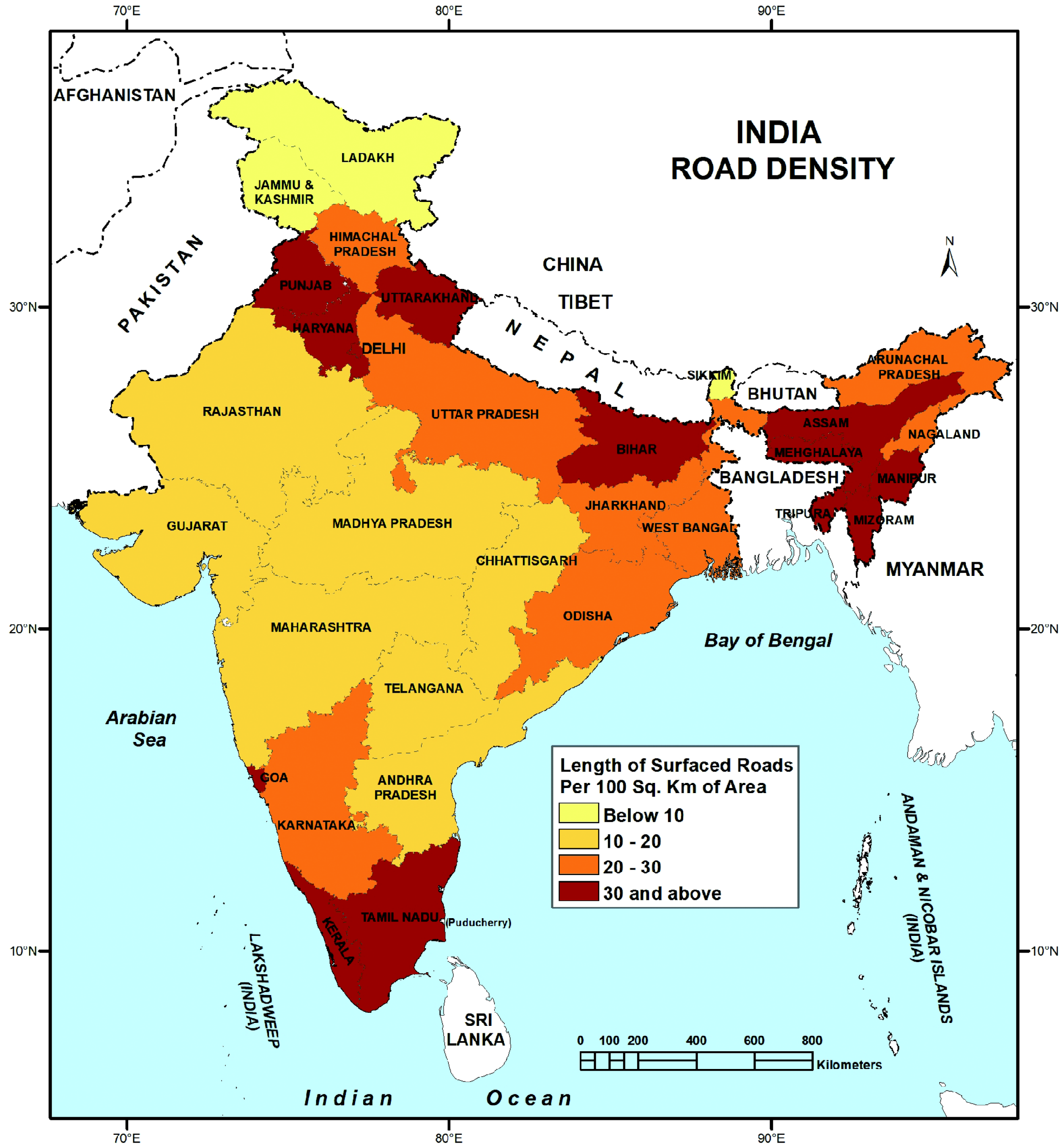


Fig. 20.2 India: Road Density

The Himalayan region and North Eastern states have a very low density of road network, which is below 20 km. per 100 square km area. As regards the pattern of surfaced roads, Punjab in the north and Kerala and Tamil Nadu in the south have the highest road density. The southern states have a good network of metalled roads. The pattern of surface road density is more or less the same as the total density of roads.

Road density in India is not uniform. It varies from region to region depending upon its relief and climatic conditions, economic development and density of population. Roads are divided

into three categories: (i) National highways (ii) State highways, and (iii) District and village roads.

i. National Highways

National Highways are the trunk roads linking major cities of the country. They are built and maintained by the Central Government. Their total length of National Highways (2019) is 1,32,499 km. Although the national highways comprise only about 2 percent of the total length of surfaced roads in India, they carry about 40% of goods and passenger traffic. Maharashtra has the highest share of National Highways (17,757 km) followed by Uttar Pradesh (11,737 km) and Rajasthan (10,342 km). National Highway 44 is the longest national highway in India. It is 4,112 kilometres long running from Srinagar in the north to Kanyakumari in the south. It connects 11 states in its journey

Fig 20.3: India: Major National Highways

Notes

ii. State Highways

The state highways are built and maintained by the State Governments. The total length of State Highways is 1,79,535 km (in 2019), out of these 1,78,384 km were surfaces and remaining 1,151 km were un-surfaced.

iii. District Roads

The District Roads comprise Major District Roads & Other District Roads constructed and maintained by State PWD. The District and village roads are looked after by the local bodies with some financial assistance coming from the states. The total length of District Roads (in 2019) were 6,12,778 km. It included 5,87,004 km of surfaces and 25,773 km of un-surfaced roads.

Border roads have been constructed on Indian international borders and its nearby areas. They connect these areas with the interior parts of the country. It's constructed and maintained by the Border Road Organisation. These roads have economic as well as strategic importance. 20,949 km of roads were under border roads in 2019.

Major Programmes/Projects

- **The Bharatmala Pariyojana :** The Bharatmala Pariyojana is a flagship programme of Government of India for the highways sector. This programme focuses on optimising efficiency of freight and passenger movement all over the country through bridging critical infrastructure gaps. To achieve this objective, the programme aims to initiate different ways i.e. development of Economic Corridors, Inter Corridors and Feeder Routes, National Corridor Efficiency Improvement, Border and International connectivity roads, Coastal and Port connectivity roads and Green-field expressways. In the first phase the programme envisages development of about 26,000 km length of Economic Corridors. It is expected to carry the majority of the Freight Traffic on roads along with Golden Quadrilateral (GQ) and North-South and East-West (NS-EW) Corridors.

- **Char Dham Pariyojna :** It is another important programme designed for improvement in connectivity for Char-Dham -Kedarnath, Badrinath, Yamunotri & Gangotri in Uttarakhand. The total length of the project is 889 km. This project after completion will make the journey safer, faster and more convenient. This project may also be strategically important due to its closeness with the international border.

20.5 PIPELINE TRANSPORT

Pipeline transport has been developed recently in India. It is the most convenient mode of transport for mineral oil, petroleum products and natural gas. Pipe lines connect oil and natural gas fields with refineries and the main market centres. Now solids are also being transported

through pipelines after converting them into slurry.

There are certain advantages of pipelines over other modes of transport (i) Pipeline can be laid through difficult terrain as well as under water. (ii) Initial cost of laying pipeline is high but subsequent cost for maintenance and operation is low. It ensures steady supply and minimises transshipment losses and delays. (iv) Pipeline operation involves very low consumption of energy. There are some limitations of pipeline transport such as the capacity of the pipeline cannot be increased once it is laid. The security of pipelines in certain areas and the detection of leakage are difficult.

Some of the important pipelines are:

- Petroleum pipelines in Assam connect oil fields with the oil refineries of Assam and Bihar.
- The Mumbai-Ankleshwar-Koyali Pipeline: This pipeline connects the offshore of Mumbai and Gujarat with the Koyali refinery in Gujarat.
- The Salaya-Koyali-Mathura Pipeline: This pipeline runs from Salaya (Gulf of Kachchh) to Koyali and Mathura through Viramgam, It is 1075 kilometre long.
- Mathura-Delhi-Ambala-Jalandhar Pipeline: This 513 km long pipeline was built to transport refinery products from Mathura to the nearby major cities..
- The Hazira-Vijaipur-Jagdishpur (HBJ) Gas Pipeline: This pipeline transports natural gas from Hazira to Vijaipur and Jagdishpur. This pipeline is the longest oil pipeline in India with a total length of 1750 kilometres.

INTEXT QUESTIONS 20.2

1. State the number of railway stations in India in 2019-20.
2. Write any two regions with dense rail network.
3. Why road network is not uniform in India?
4. What is the total length of Char-Dham Pariyojna.

20.6 WATER TRANSPORT

India has a long coastline including island groups which is over 6100 km. This long coastline is dotted with 12 major ports managed by the central government. Then there are 200 minor ports operating under the jurisdiction of the state governments. These major ports alone handled 672.68 million tonnes of sea traffic. Out of the 200 non-major ports, around 65 ports

are handling cargo. The remaining ports have "Port Limits" and no cargo is handled. These ports are used by fishing vessels and by small ferries to carry passengers across the creeks etc. The capacity of the ports has increased five times since 2001-02. In the year 2001-02, the port capacity was 343.95 million tones which increased to 1560.61 million tones in the year 2020-21.

The major ports along the western or Arabian Sea coast are Deendayal Port (at Kandla), Mumbai, JawaharLal Nehru Port (at Nhava Sheva on the opposite side of Mumbai harbour), Marmugao, New Mangalore and Cochin. Thus all the states on the western coast have at least one major port. The remaining five ports are Tuticorin, Ennore, Chennai, Visakhapatnam, Paradeep (Paradip) and the Joint port of Kolkata - Haldia. These ports connect India with the world and play a major role in the success of international trade and commerce.

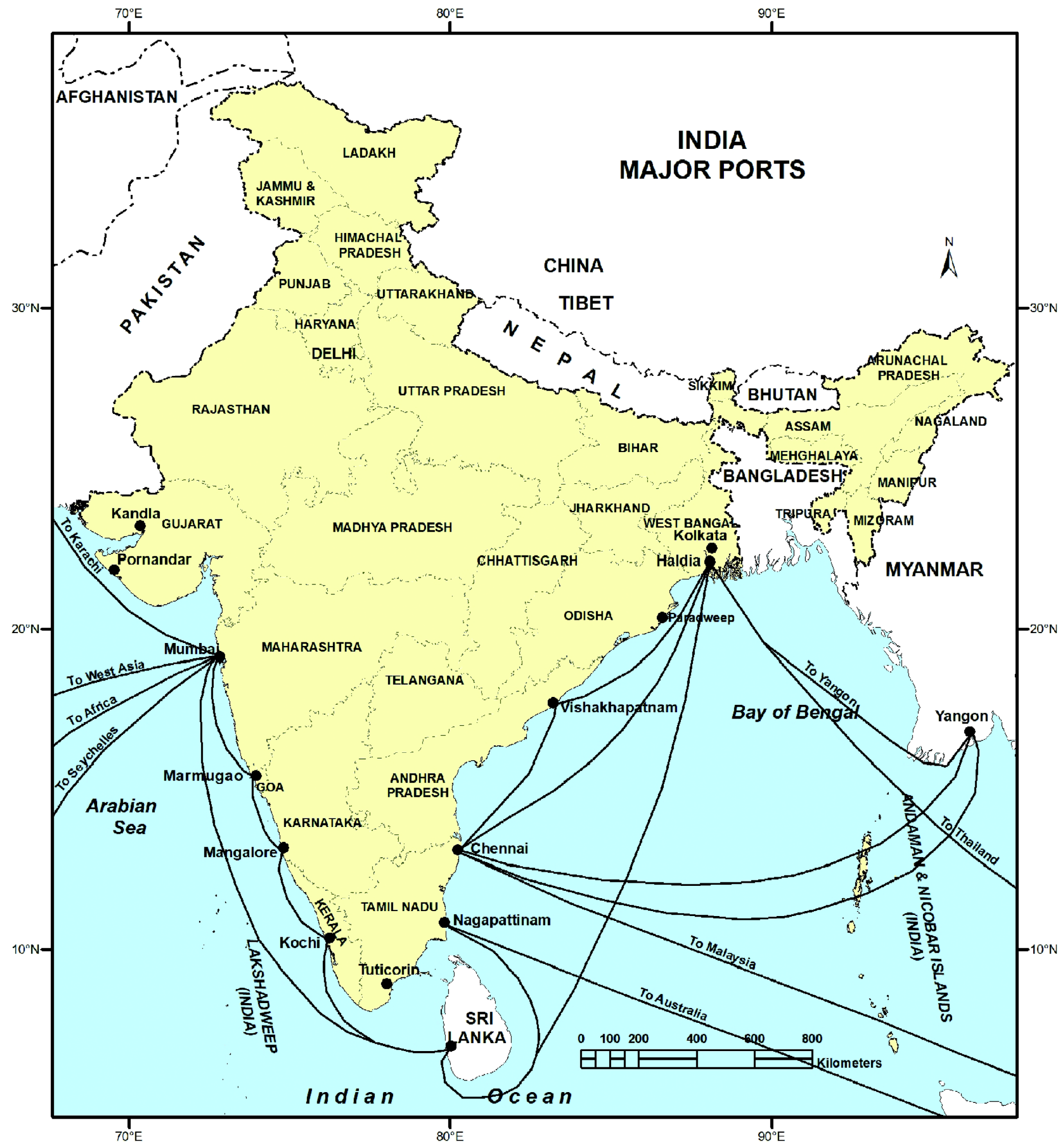


Fig. 20. 4: India: Major Ports

Inland WaterWays

India has the potential of extensive waterways in the form of rivers, canals, backwater etc. The waterways may be cost effective in comparison with other modes of transportation. However, this potential is not fully developed and underutilised. Under the National Waterways Act, 2016, 111 inland waterways have been declared as 'National Waterways' in the country to promote shipping and navigation on them. The total length of National Waterways is 20,275 km spread across 24 States in the country.

Major National Waterways (NW)

NATIONAL WATERWAY 1 (NW-1)- The Ganga river system between Haldia and Prayagraj was declared as National Waterway-1 (NW-1) in 1986. It covers a distance of approx 1620 km.

i. **NATIONAL WATERWAY 2 (NW-2)-** The river Brahmaputra having a length of 891 Km between Bangladesh Border and Sadiya has been declared as National Waterway no. 2 (NW-2) in 1988.

ii. **NATIONAL WATERWAY 3 (NW-3)-** The network of canals in Kerala with the total length of 205 km has been declared as National Waterway-3 in 1993.

iii. **NATIONAL WATERWAY 4 (NW-4)-** The stretch of Canals between Kakinada-Puducherry, integrated Bhadrachalam - Rajahmundry stretch of River Godavari and Wazira Vijayawada stretch of River Krishna with the total length of 1078 km was declared as National Waterway-4 in 2008.

iv. **NATIONAL WATERWAY 5 (NW-5)-** The Talcher- Dhamra stretch of river Brahmani, Geonkhali- Charbatia stretch of East Coast Canal, Charbatia- Dhamra stretch of Matai river and Mangalgadi-Paradip stretch of Mahanadi delta rivers with the total length of 623 km was declared as National Waterway-5 in 2008.

The following factors affect the inland waterways in India:

- Diversion of water of rivers for irrigation.
- Silting of river beds reduces the depth of river water.
- Seasonal fluctuations in the water level of the rivers.
- Presence of bridges, waterfalls and cataracts in the course of rivers.
- An unequal competition with railways and road ways.

India's inland waterways have not been developed as they can not compete with the railways and roads.

Major Programmes/Projects

Sagarmala

India has 7500 km long coastline and 14,500 km potential navigable waterways but still this potential is underutilised. Last mile connectivity to the ports is one of the major hurdles for movement of cargo to/from the hinterland. The location of industries and manufacturing centres may also be away from the port area and not well connected. Sagarmala project is an ambitious national initiative aimed at bringing about a step change in India's logistics sector performance, by unlocking the full potential of India's coastline and waterways. As per the Ministry of Ports, shipping and Waterways, Govt. of India, the vision of the Sagarmala is 'the vision of Sagarmala is to reduce logistics cost for both domestic and EXIM cargo with optimised infrastructure investment.' It includes-

- Reducing cost of transporting domestic cargo through optimising modal mix
- Lowering logistics cost of bulk commodities by locating future industrial capacities near the coast
- Improving export competitiveness by developing port proximate discrete manufacturing clusters
- Optimising time/cost of EXIM container movement

The components of Sagarmala are-

- Port Modernization and New Port Development
- Port Connectivity Enhancement
- Port-linked Industrialization
- Coastal Community Development
- Coastal Shipping & Inland Waterways Transport

20.7 AIR TRANSPORT

Air transport is the fastest and highly convenient mode of transport, although it is more costly than other modes. However, it is one of the growing modes of transportation. You can visit places which are far away in a shorter time in comparison with other modes. If you are residing in Uttarakhand and want to go to Chennai, you can reach within a few hours by an aeroplane while this distance is covered in more than one day by a railway express train.

Air transport becomes very important in the regions where surface means of transport are difficult to develop due to difficult terrains i.e. dense forests, marshy land, hilly terrain and high mountains.

India is favourably situated on a busy international air route, connecting North America, Europe and South-west Asia on the one hand and East and South-east Asia together with Australia on the other.

As on 31st December 2022, there were fifteen (15) scheduled commuter operators viz. Air India Ltd., Alliance Air, Air India Express Ltd., Jet Airways(India) Ltd., SpiceJet Ltd., Go Airlines (India) Pvt. Ltd., InterGlobe Aviation Ltd. (Indigo), Air Asia Pvt. Ltd., Tata SIA Airlines Ltd. (Vistara), SNV Aviation Pvt. Ltd. (Akasa Air), Ghodawat Enterprises Pvt. Ltd. (Star Air), GSEC Monarch and Deccan Aviation Pvt. Ltd. (IndiaOne Air); Aviation Connectivity and Infrastructure Developers Pvt. Ltd.(AIR TAXI), Big Charter Pvt. Ltd.(Fly Big) and Pawan Hans Ltd. These operators are operating in the domestic sector and provide wide choices of flights and connectivity to various parts of India. Some of these are also operated on international routes.

Fig. 20.5: India: Major Airports

Notes

There are two cargo airlines viz. Blue Dart Aviation Ltd. and Quick Jet Cargo Limited operate scheduled cargo services in the country. Further, SpiceJet Ltd. was also operating Cargo Operations with five (5) B737 Freighter aircraft.

The Airport Authority of India is responsible for providing safe and efficient air traffic services. It also provides aeronautical communication services for control of air traffic in the Indian air space. There are 131 operational airports in India. This include 29 international airport.

Major Programmes/Projects

Regional Connectivity Scheme (RCS-Udan)

The Ministry of Civil Aviation has started the Regional Air Connectivity under Regional Connectivity Scheme (RCS) -Ude Desh ka Aam Nagrik (UDAN) on 21.10.2016. It is a flagship programme of the Government of India. 459 RCS routes have been operationalised till date. It connects 72 RCS airports (including 9 heliports and 2 Water Aerodromes). 113 lakhs passengers have used the services of UDAN yet.

20.8 COMMUNICATION AND ROLE OF ICT

Communication is one of the important pillars of the development of a country. It is a system which contributes to the development of the economy, social relationships and also helps in promoting cultural unity. On the other hand, it brings diverse people and cultures of the world close to one another. It is also very important during any accident; calamity or emergency because instant means of communication flash the news across the globe so that relief can be rushed to the spot immediately. Let us discuss some of the major means of communication in India:

Postal Services

It is the most commonly used mode of communication in India. The postal services play a vital role in the rural areas of the country. About 99% of the villages are enjoying postal services today. At present (2021) the postal department is working with a network of 1,59,392 post offices including 808 Head post offices, 24281 Sub post offices and 1,34,303 Branch post offices to provide postal services covering every part of the country. 4,28,773 letter boxes have been installed across the country. It is providing a wide range of services i.e. delivery of mails, issuing of stamps, deposits under Small Savings Schemes, life insurance cover under Postal Life Insurance (PLI) and Rural Postal Life Insurance (RPLI) and retail services like bill collection, sale of forms, Post Office Passport Sewa Kendras etc.

It also acts as an agent for the Government of India in discharging other services for citizens such as old age pension payments etc. In tune with the rest of the world the Indian postal services are also being modernised.

Notes

Telecommunication

Innovation has changed the faces of modern day's communication. It provides individual as well as group communication at a very affordable cost and is easy to access. Telephone and Fax are the main means of telecommunication. With the launching of 4G and 5G services, telecommunication has become fast and effective. India currently has the world's second-largest subscriber base of 1.17 billion.

Telephone: There has been a very fast progress in telephone facilities. As of October, 2022 India has a total 117.02 crore telephone connection. India also has 114.4 crore mobile connections in October 2022. For the same period, India has 84.67% tele-density.

Telecommunication has observed a big change in technology. 5G services were launched in India on 1st October 2022. 5G use cases developed by Telecom Service Providers and start-ups in Education, Health, Worker safety, Smart agriculture etc. are now being deployed across the country. The telecom services are provided by both the public and private sector. Presently, India has 6 telecom service providers.

Mass - Communication

The mass communication includes radio, television, newspaper, magazines and internet based websites and portals. Radio and television are the electronic media of mass communication. They play an important role in individual and social life. Later on June 8, 1936, the Indian State Broadcasting Service became All India Radio. There are 470 Broadcasting centres located across the country. These stations cover about 92% of the country's area and 99.19 % of the total population. All India Radio offers programmes in 23 languages and 179 dialects. Now, FM Radio services have given a new face to radio transmission.

Television service was started in 1959 in India. However, the real expansion of T.V. Service began after 1980. Several channels on television have been made available to private parties. This has promoted keen competition to improve the quality of programmes even of Doordarshan. Doordarshan's network consists of (i) 66 Doordarshan Kendra (studio centres) including 17 major studio centres at state capitals. Doordarshan has a network of 34 satellite channels. DD1 provides services in more than 79% of area and about 91% of the total population.

The television industry is also functioning in private sectors and many channels in the area of entertainment, news, infotainment etc in various languages are operational. Cinema is yet another means of mass communication. It entertains millions of people everyday.

Print media

Newspapers, periodicals and journals fall in the category of print media. Print media expanded very rapidly after independence. The total numbers of registered publications as on 31st March, 2018 were 1,18,239. Out of these 17,573 were under newspaper category and remaining 1,00,666 were periodicals. The largest number of newspapers and periodicals

registered in any Indian language is in Hindi (47,989) followed by English (14,626).

Role of ICT

The world is changing so fast and so are the technologies. Information and Communication Technology (ICT) has made a significant impact on human lives. It gives an opportunity to its users to be a part of a very fast changing world. It also allows connecting with other advanced technologies around the world.

India has witnessed the effective use of ICT in different aspects of life and economy. India's core digital economy has added 8.5 % of Gross Value Added (GVA) in 2019. Its growth is 2.4 times faster than the Indian economy. Around 62.4 million workers are employed in a digitally dependent economy. The contribution of the digital economy in India's GDP was approx 8.49% in 2019. It included the three main sub-sector - (i) computer, electronics, and optical products; (ii) telecommunications; (iii) computer and ICT services.

Use of ICT is not limited to certain sectors but it has been widely accepted and expanded its role in industry and economy. Construction, food and beverage, textile, electrical and other electronic equipment, education, retails trade, finance etc are some examples where ICT is playing a crucial role. As per RBI Bulletin, December 2022, 4.9 million people were employed in the core digital sector. The report also says that in the total digitally dependent economy, around 62.4 million workers are employed in sectors that are digitally disrupted.

ICT has touched various aspects of life. The Digital India programme is one of such programmes which has made significant changes. It is a flagship programme of the Government of India with a vision to transform India into a digitally empowered society and knowledge economy. This has changed the face of digital payment in India and is continuously increasing. The number of transactions has been increased from 2071 crore in 2017-18 to 8840 crore in 2021-22.

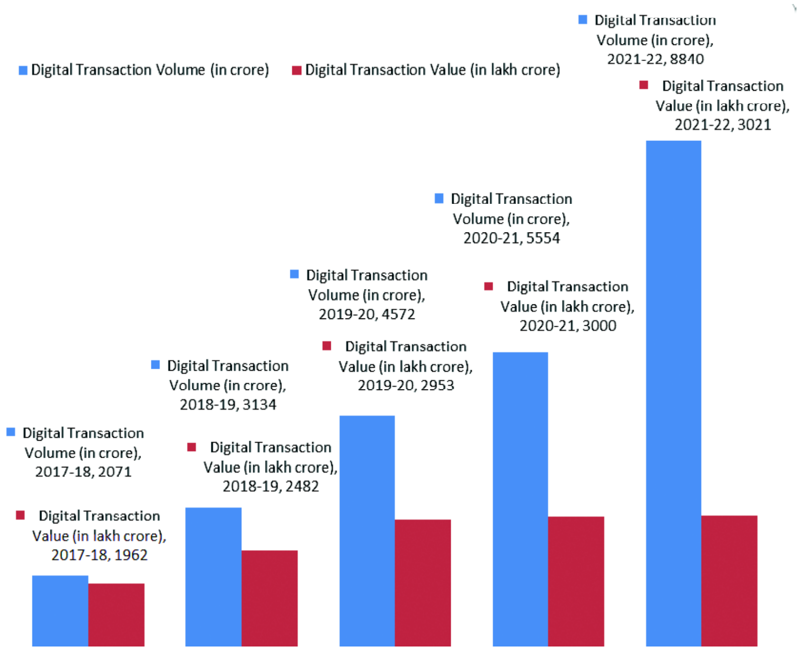


Fig. 20.6 Digital Payments in India

20.9 TRADE

The services which involve the activities of buying and selling of goods are termed as trade. Like transport, communication, banking etc. it is also a tertiary service and an important infrastructure for the development of the economy including agriculture and industry in the country. Trade may take place at various levels -local, regional, national or international.

The growth of trade depends on accessibility of a well developed market and well advanced communication system.

International Trade

International trade involves the selling and buying of various commodities at the international level. International trade may be multilateral or bi-lateral; depending upon the number of parties involved. India's international trade has grown very rapidly after Independence. India's total international trade in the year 1950-51 stood at Rs. 1,214 crore. Since then this has witnessed continuous increase with occasional downwards twins. The opening of the economy, liberalisation and globalisation have boosted international trade. During the year 2021-22 the value reached Rs. 77,19,796 crores. Though India has trade relations with all the major trading blocs and all the geographical regions of the world, the major trade partners are the USA, Russia, countries of West Europe, Japan and Oceania. Europe (6,42,717 crore) and North America (6,29,080 crore) are important trading blocs which comprise large parts of India's exports. North East Asia, Commonwealth of Independent States (CIS), Africa and Oceania are other important trade blocs.

Export

Major commodities of our exports before independence were either raw materials like cotton, jute, leather, spices, minerals or food items like wheat, tea, coffee and spices etc. All the trade was channelised through Britain. After Independence there have been significant changes in the items of export because of the rapid industrial development in the country. Now India exports more than 7500 commodities. There has been an appreciable growth in exports since 1950-51 when it was worth only Rs. 607 crores. It has increased to Rs. 31,47,021 crores by 2021-22.

There are year to year variations in the commodities exported. However, petroleum products remain on top of exported principal commodities from the last few years. Top five principal commodities exported from India are petroleum products; pearls, precious and semi-precious stones; iron and steel; drug formulation and biological; and gold and other precious metal jewellery. There has been a significant change in the export products since Independence. The top five countries where commodities were exported are the USA, UAE, China, Bangladesh and Netherland.

Imports

After Independence, there has been a sharp increase in the value of imports in India. We now import more than 6000 commodities. During the pre-Independence period, the main items of imports were machinery, manufactured goods, textiles, chemicals, medicines etc. After independence in the early decades, India's import consisted mainly of food grains because of the partition of the country. India's total value of import in 1950-51 was of Rs. 581 crores which had increased to Rs. 45,72,775 crores in 2021-22.

Due to growing demand and insufficient reserves India has to import huge quantities of crude petroleum to fulfil its domestic requirements. The crude petroleum comes on top of important principal commodities. It is followed by gold; petroleum products; coal, coke and briquettes and pearls, precious and semi-precious stones. The other principal imports consist of machinery, project goods, medicinal and pharmaceutical products, organic and inorganic chemicals, artificial resins etc.

Balance of Trade

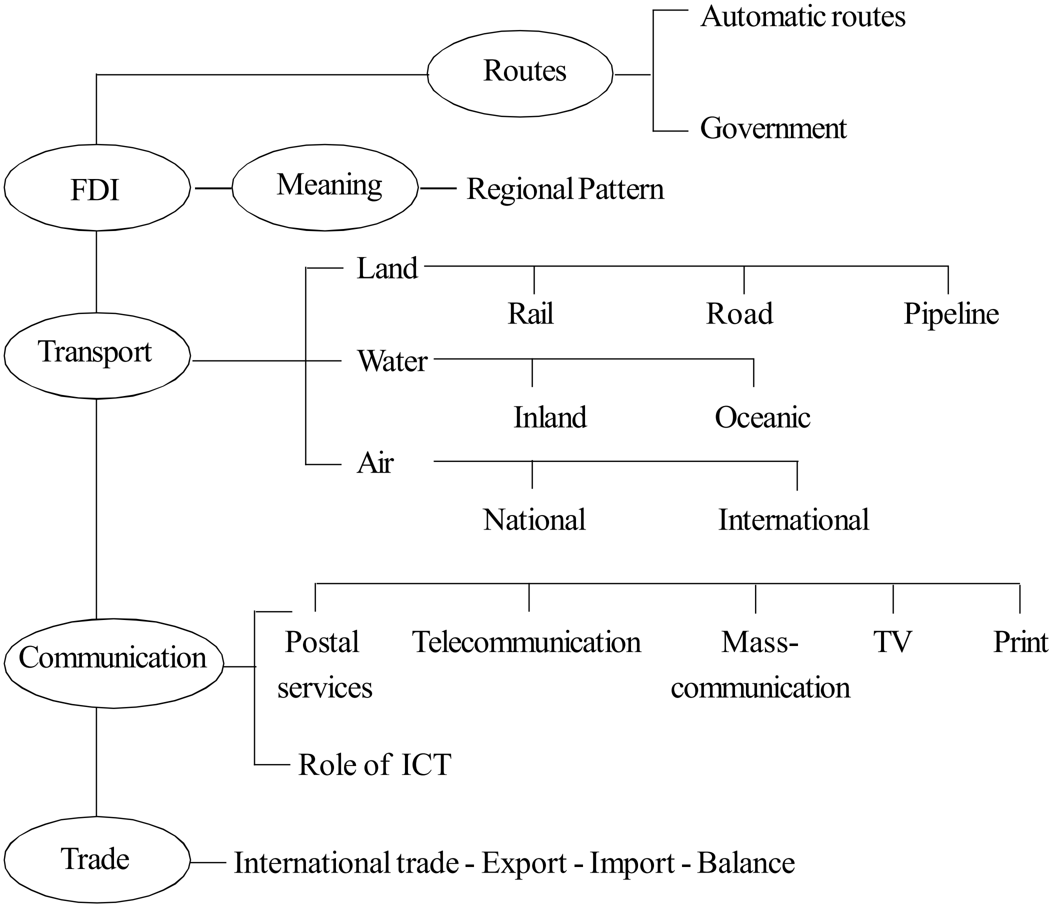
Difference between the value of exports and imports is termed as balance of trade. When the value of exports and imports of a country is equal it is a situation of balanced foreign trade. If exports exceed imports, It is favourable; and on the other hand when imports are more than exports, it is unfavourable trade.

At the time of Independence, our foreign trade was favourable but after Independence, in the first two decades, the imports of India increased rapidly due to the imports of food grains. At present the imports of the country exceed the exports. Thus, our foreign trade has become unfavourable. In rupee terms, the trade deficit in 2021-22 was Rs. (-) 14,25,753 crore. It is worth noting that our exports and imports have increased in volume and value remarkably.

INTEXT QUESTIONS 20.2

1. What is the name of waterways between Haldia and Prayagraj?
2. How may scheduled Computer Operators are in India?
3. In which year RCS-Udan scheme was launched?
4. State the number of Post Office in India.
5. What was the trade defict of India in 2021-22.

WHAT YOU HAVE LEARNT



TERMINAL QUESTIONS

1. Define Foreign Direct Investment.
2. Explain two routs of FDI in India
3. Highlights the regional pattern of FDI in India
4. Explain the distributions of rail network in India.
5. Why road transport is important?
6. Write short not on
   i) National Highways
   ii) Bharatmala Pariyojna

iii) RCS-Udan

7. How ICT is making Positive changes in India? Explain

8. Write a brief note on trade in India.

ANSWERS TO INTEXT QUESTIONS

20.1

1. b
2. c

20.2

1. 7325
2. Northern Plain, Eastern coastal area, Plains of Gujrat etc
3. Uneven due to relief, climatic condition, density of population
4. 889 KM

20.3

1. National Water way 1
2. 15
3. 2016
4. 159392
5. (-) 14,25,753 crore.

MODULE -9

Human Resource Development in India

21. Population Growth and Distribution

22. Population Composition

23. Human Development

21

POPULATION GROWTH AND DISTRIBUTION

In the previous two moduleswe have discussed in detail about various natural resources and major economic activities of India. They include land,soil, water, mineral, forest, and wildlife resources. We have also analysed thedistribution of these above mentioned resources as well as their utilization. All these aspects were studiedin relation to people living in the country. By people we mean not only their numbersas consumers but also as developers or managers of natural resources. For thispurpose, we look at their educational and health status, their vocational, technical,and social skills and above all their aspirations, value system. In this context you would realise that people are not mereconsumers but also constitute the most important resources of a country. In thislesson, we will describe the size of India's population in the world context. We will also analyse trends in population growth, their determinants and consequences. We willexplaindistribution and density of population and analyse various factors influencing them.In the concluding section, we will discuss challenges of growing population.

OUTCOMES

After studying this lesson, Learner

- describes the size of Indian population in the world perspective;
- explains the trends in population growth since 1901;
- analyses factors responsible for uneven distribution of population; and
- explainthes issues and challenges of growing population.

21.1 POPULATION SIZE AND GROWTH

Before discussing in details about growth and distribution of population in India in detail, let us know about the size of population in India in relation to its total area. Let us analyse Indi's total

population and area in comparison to world population and area. This would provide you an idea about Indi's population concentration. In the below given section, a detailed discussion has been presented about this. This would help you to critically analyse population related issues and challenges in India.

A Population Size

You might be knowing that India is the second most populous country in the world next only to China. According to 2011 Census, the total population of India was at 1,210,854,977(about 1210 million or 1.21 billion). This accounted for 16.7% of the world's total population. In other words, about every sixth person in the world there is an Indian.India possesses only 2.42% of the world's total land area.In terms of area, India stands seventh preceded by Russia, Canada, China, the United States of America, Brazil and Australia. Barring China, the total population of these large five countries is far less than that of India. The total area of these five countries is over sixteen times whereas their total population is much less than that of India (Fig. 21.1). It can also be revealed from the fact that the total population of North America, South America and Australia added together is less than the population of India. On the top of it, we are adding over 17 million people each year. It is more than the total population of Australia. In fact the net addition to Chinese population each year is less than India.

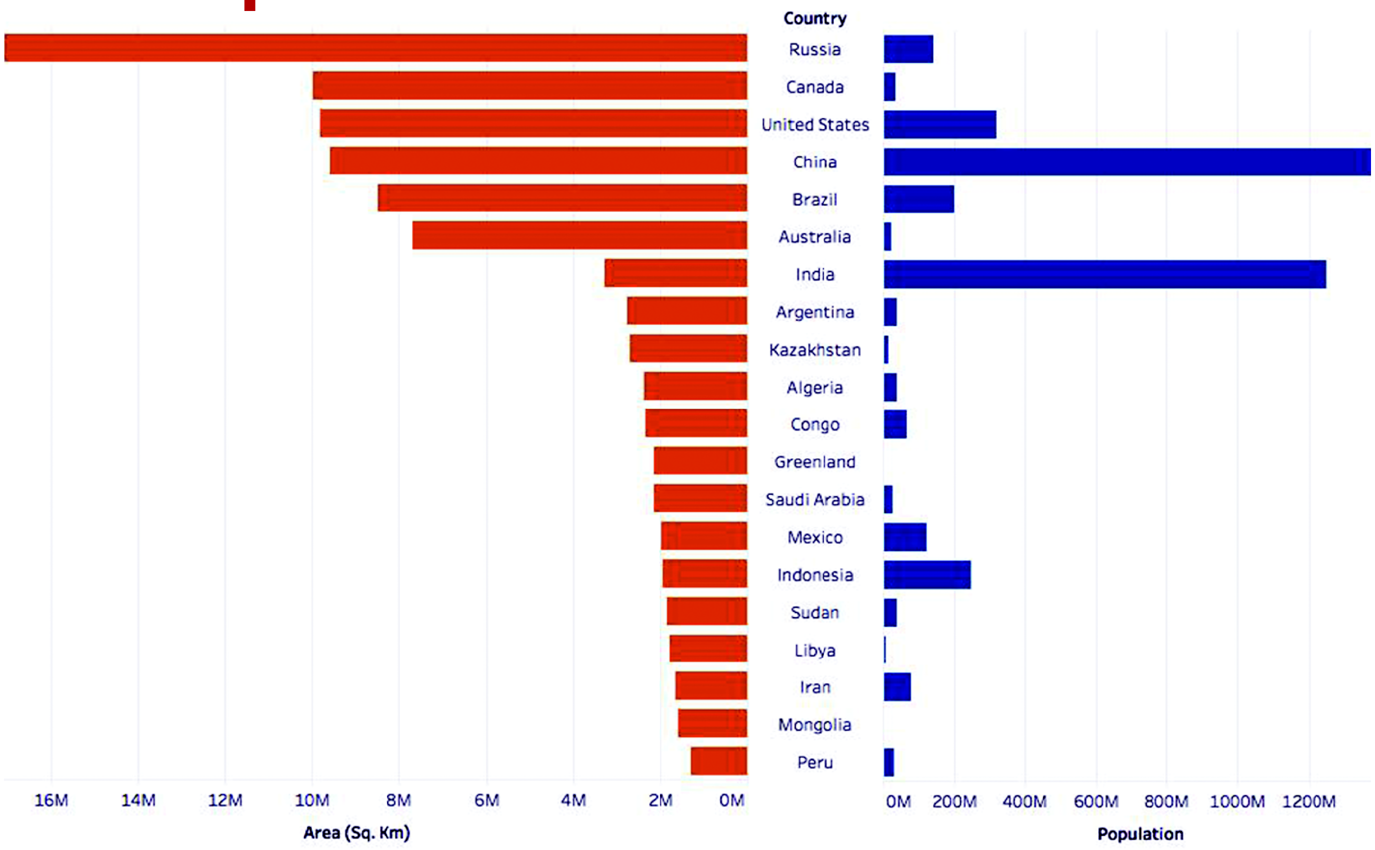


Fig. 21.1: Countries by Land Area and Population Size

Notes

B Growth of Population

Do you have any idea about the trend of growth of population? When we say trend it means the changes in number of population over the years. Do you know what the determinants responsible for the population growth are? The growth of population in a region depends upon three factors namely birth rate, death rate and migration. Birth rate is measured in terms of total number of live births per thousand populations per year. Generally, birth rate is affected by various social, economic and demographic factors. Similarly, death rate is measured in terms of total number of deaths per thousand population per year. The difference between birth rate and death rate is known as natural growth rate. The term migration refers to the movement of people from one area to the other or from one country to another. The rate of migration affects the growth of population of a region by increasing or decreasing the number of people living there.

Natural Growth = Birth Rate - Death Rate

Actual Growth Rate = Birth Rate - Death Rate + In Migration - Out Migration

The growth rate of population may be positive or negative. A positive growth rateof population mean an increase in the number of people living in a region, whereasnegative growth rate means declining population. A positive growth rate occurswhen the number of births and in migration exceeds the number of deaths and outmigration. On the other, the negative growth rate means just opposite to positive growth rate i.e. the number of deaths and out migration exceeds the number of birth and out migration.

Look at the table 21.1, you will find that the total population of our country, was 238 million. By 2011, it had risen to a phenomenal figure of 1027 million. About 972 million persons were added in the last century. The rise is of about 4.3 times since 1901.

Table 21.1: India: Decadal Growth of Population 1901-2011

Census Year	Total Population (in million)	Absolute Growth	Growth in Percentages	Decadal Growth
1901	238.40	-------	------	-----
1911	252.09	+ 13.70	5.75	0.56
1921	251.32	-0.77	-0.31	-0.03
1931	278.98	+11.00	11.00	1.04
1941	318.66	+39.68	14.22	1.33

1951	361.09	+42.43	13.31	1.25
1961	439.23	+78.15	21.64	1.96
1971	548.16	+108.92	24.80	2.22
1981	683.33	+135.17	24.66	2.22
1991	843.39	+163.06	23.86	2.14
2001	1027.02	+180.63	21.34	1.93
2011	1210.19	+181.58	17.64	------

Source: Census of India

If we look at the 100 years populationgrowth then, it can be broadly grouped under the following four categories (Fig. 21.2).

1. Period of stagnant growth rate (before 1921)
2. Period of steady growth rate (1921-1951)
3. Period of rapid growth rate (1951-1981)
4. Period of declining growth rate (after 1981)

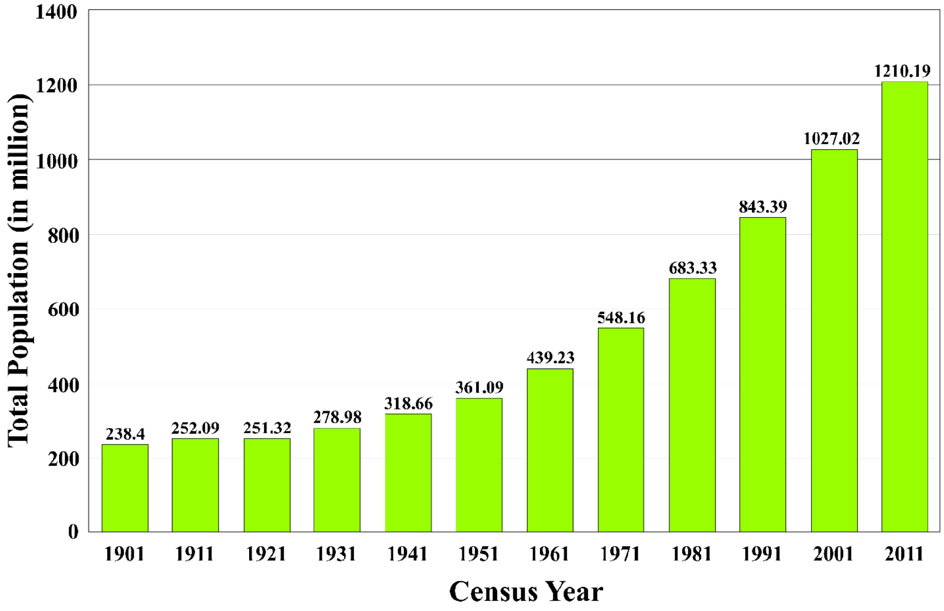


Fig. 21.2: India: Trend of Population Growth 1901-2011

Notes

Let us discuss each phase briefly.

1. **Period of stagnant growth rate (before 1921):** Before 1921 the increase in population was sporadic, irregular and slow.This was mainly due to high birth and death rate. Therefore, the natural growthwas insignificant. In 1911-21 the absolute increase declines marginally dueto famines, epidemics etc. After 1921 the population has been increasing.Therefore, 1921 is known as demographic divide in the population study ofIndia.

2. **Period of steady growth rate (1921-1951):** Since 1921 to 1951 there was a steady increase in population. This is becauseof steady decline in death rates. The decline was mainly due to improvementin sanitation and medical facilities. Other factors which helped weredevelopment in road facilities which helped in meeting the exigencies of foodshortage and substantial improvement in agricultural economy. Therefore,the population growth during this period was known as mortality inducedgrowth.

3. **Period of rapid growth rate (1951-1981):**This is a very crucial phase as far as population growth of India is concerned.The population was almost doubled during these three decades. During thisperiod there was a rapid decline in death rate whereas the decline in birthrate was marginal. Look at the table, you will find birth rate was reducedfrom 41.7 to 37.2 whereas death rate was reduced from 22.8 to 15.0 duringthis period. Therefore the difference between birth rate and death rate wasvery high and as a result natural growth rate remains very high. This was dueto acceleration in developmental activities further improvement in medicalfacilities, improvement in living conditions of the people etc. This period of growth is termed as fertility induced growth.

4. **Period of declining growth rate (after 1981):** In the last three decades i.e. 1981-91, 1991-2001, and 2001-2011 the rate of growthstarted declining gradually. It indicates the beginning of a new era in thedemographic history of India. During this period birth rate declined significantly,from 37.2 in 1971-81 to 24.8 in 1991-2001 whereas the decline in deathrate continued in a slower rate. The death rate has declined from 15.0 to 8.9during this period. This declining trend is a positive one and may be attributedto effective government role in promoting family welfare programmes andpeople's awareness.

Regional Variation in Population Growth

Till now we have discussed the growth rate over a 110 years' time period. But do you know how this growth rate varied over the space.The growth rate of population during 1991- 2001 in Indian States and Union Territories shows very obvious pattern. The States like Kerala, Karnataka, Tamil Nadu, Andhra Pradesh, Odisha, Puducherry, and Goa show a low rate of growth not exceeding 20 per cent over the decade. Kerala registered the lowest growth rate

(9.4) not only in this group of states but also in the country as a whole. A continuous belt of states from west to east in the north-west, north, and north central parts of the country has relatively high growth rate than the southern states. It is in this belt comprising Gujarat, Maharashtra, Rajasthan, Punjab, Haryana, Uttar Pradesh, Uttarakhand, Madhya Pradesh, Sikkim, Assam, West Bengal, Bihar, Chhattisgarh, and Jharkhand, the growth rate on the average remained 20-25 per cent. During 2001-2011, the growth rates of almost all States and Union Territories have registered a lower figure compared to the previous decade, namely, 1991-2001. The percentage decadal growth rates of the six most populous States, namely, Uttar Pradesh, Maharashtra, Bihar, West Bengal, Andhra Pradesh and Madhya Pradesh have all fallen during 2001-2011 compared to 1991-2001, the fall being the lowest for Andhra Pradesh (3.5% percentage points) and highest for Maharashtra (6.7 percentage points). Tamil Nadu (3.9 percentage points) and Puducherry (7.1 percentage points) have registered some increase during 2001-2011 over the previous decade (Fig. 21.3).

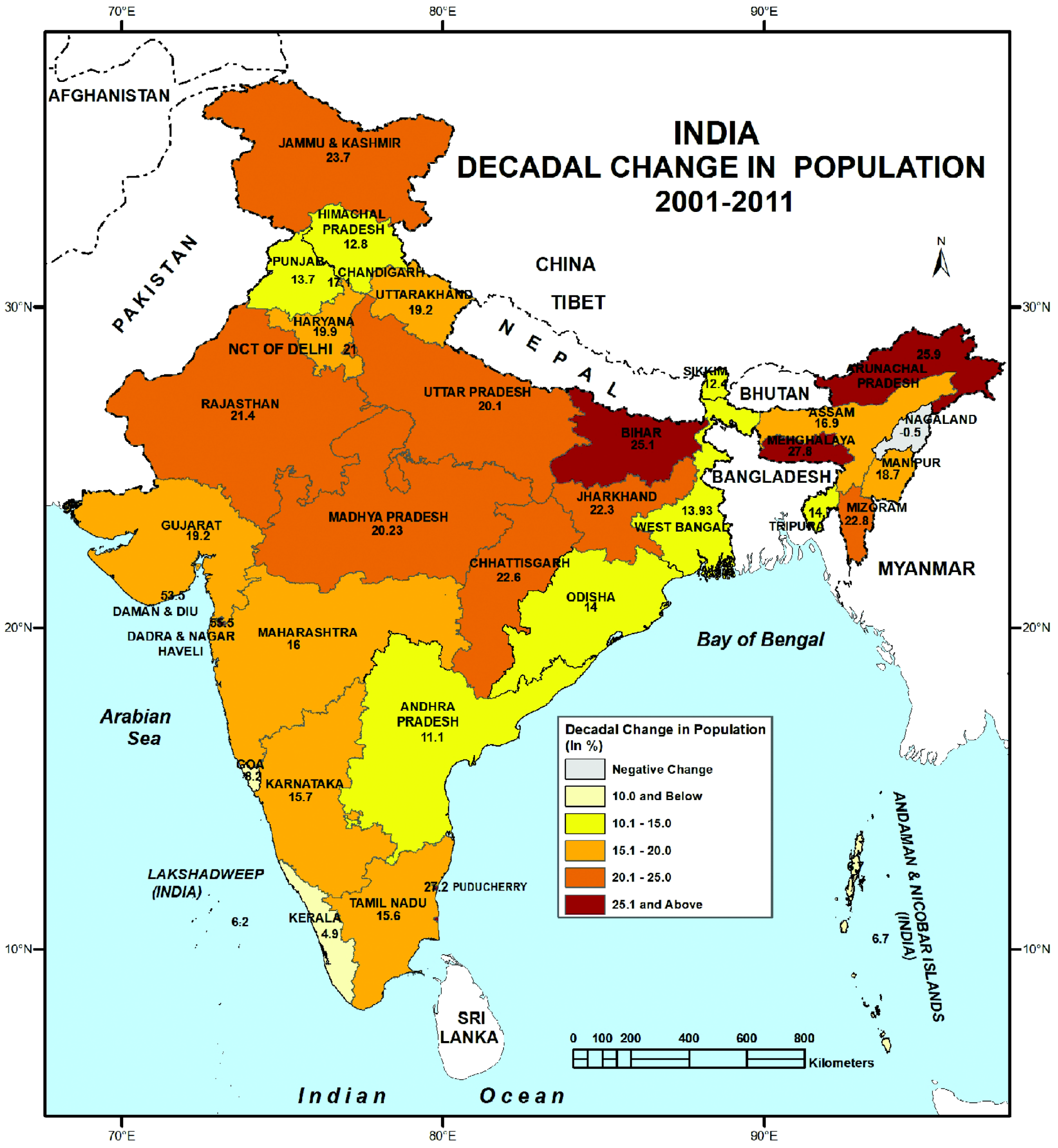


Fig. 21.3: India: Population Growth 2011

INTEXT QUESTIONS 21.1

1. Tick (√) Mark the most appropriate answers

   (a) The major reason for the high growth rate of population in India is:

   (i) rapidly rising birth rate

   (ii) rapidly falling death rate

   (iii) high in-migration from outside

   (iv) very high birth rate and death rate

   (b) The growth rate of population in India has been constantly rising right since

   (i) 1901

   (ii) 1921

   (iii) 1951

   (iv) 1981

2. Name the State where the growth rate of population is the highest and lowest according to 2011 Census.

   ____

3. Name the states where the growth rate of population is the lowest.

   ____

21.2 POPULATION DISTRIBUTION

Population of the world or of any country is not uniformly distributed. The same is true about India also. Some parts of the country are densely populated, some parts moderately populated and some parts are sparsely populated. (Fig. 21.3). For example hilly and forested region of the Himalaya are sparsely populated whereas plain and fertile areas in and around Ganga river are densely populated. Do you know why it is so? There are various factors responsible for such variations. These factors can be broadly grouped under two categories namely physical and socio-economic.

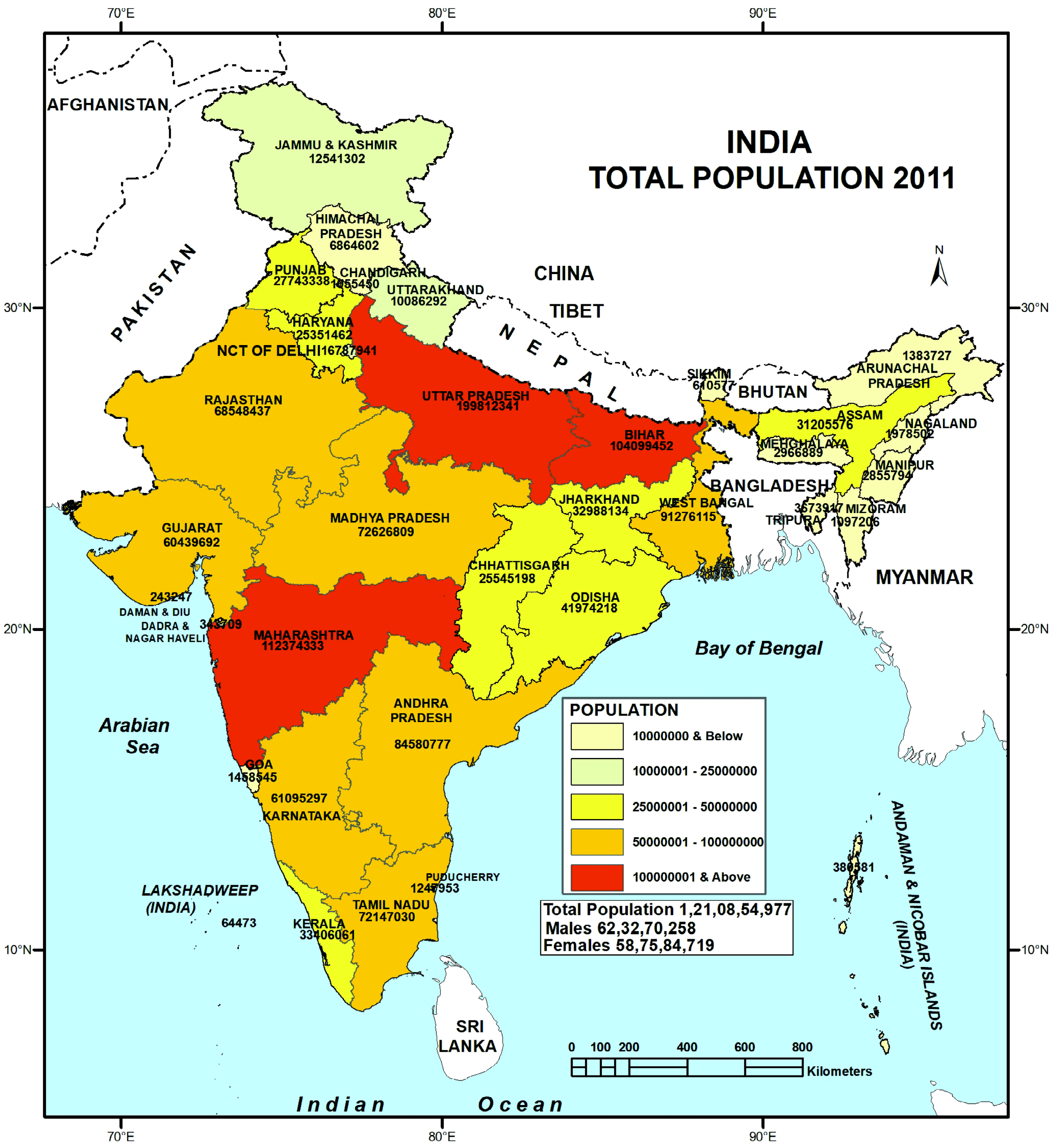


Fig. 21.4: India: Distribution of Population (2011)

Factors Influencing Distribution of Population

As we discussed earlier, the spatial spread of population in India is not uniform. There are very wide regional variations. Let us analyse various factors that are responsible for such variations. All such factors affecting the population distribution may broadly be grouped into

two major categories. They are (A) physical factors and (B) socio-economic factors.

A. Physical Factors: Physical factors play a vital role in the density and distribution of population. Physical factors include landform, climate, soil, etc. Though there is a lot of improvement in technology but the patterns of population distribution all over the world continues to reflect the influence of varied physical factors.

(i) Landforms: The most important attributes of landforms which determine population distribution are the altitude and slope. The most striking evidence of the influence of altitude and slope on population distribution have been observed between mountains and plains. For example, take the case of most densely populated Indo-Ganga plains on the one hand and mountainous state of Arunachal Pradesh on the other. Other than this, factors like drainage, and water table have also been affecting population distribution.

(ii) Climate: It is one of the essential elements of the physical factors which influence the spatial distribution of population. Major elements of climatethat affect the distribution of human population are temperature conditions and the amount of precipitation. Take the case of hot and dry deserts of Rajasthan and the cold and wet Eastern Himalayan region of the country where very low temperature and heavy precipitations prevail. Apart from other reasons namely steep slope, poor soil, this is also one of the major reason for sparse population in these regions. Almost even distribution and high density of population are found in coastal plains of Kerala and Ganga plains of Uttar Pradesh, Bihar and West Bengal where rainfall is moderate to high.

(iii) Soil: As mentioned above, it is another factor which affects the density and distribution of population. One may be tempted to question the validity of the role of soil in the present day highly industrialised society. But, even today, about 70 percent of population in India lives in villages. People in villages earn their livelihood from agriculture which depends upon the quality of soil. That is why alluvial region of northern plains and coastal and deltaic regions of India continue to support high concentration of population. On the other hand, it may be worth mentioning that vast tracts of land in desert areas like Rajasthan, Rann of Kuchchh in Gujarat,Terai region in Uttarakhand have been suffering from problems like soil erosion and soil effloresce which support only low concentration of population.

In any region, the distribution is influenced by more than one factor. Take for example North-Eastern region of India. Here several factors are responsible for low density of population. These factors are high rainfall, rough terrain, dense forests and poor quality of soil.

Notes

B. Socio-Economic Factors: Like physical factors, socio-economic factors also play an equally important role in the distribution of population. However, there may not be a perfect agreement upon the relative importance of these two determinants. In certain places physical factors play a vital role whereas in some places socio-economic factors have a greater impact. Various socio-economic factors which have impact upon the population distribution are (i) socio-cultural and political factors; (ii) availability of natural resources.

(i) Socio-Cultural and Political Factors: Let us explain this factor with an example. Mumbai-Pune industrial complex is a good example to show how social, cultural, historical and political factors collectively have contributed to rapid growth of population. About 500 years ago, there were small insignificant islands of the Thana Creek on the western coast. The adventurous Portuguese seamen claimed these islands for their monarch. They in turn gifted these islands to the Royal Family of England by way of dowry. These couple of sleepy fishing village located on these islands could never guess that they would shortly turn into India's largest population conglomeration. East India Company of England set up a trading centre on these islands and later made it the capital city of Bombay Presidency. Enterprising trading and business communities of Parsis, Kuchchhis and Gujaratis played a leading role in setting textile mills, development of water power and laying roads and railways across the Western Ghats connecting it with its hinterland. Unexpectedly, the Suez international navigation canal made Mumbai the nearest Indian port to Europe. Availability of educated youth from Mumbai and Pune and inexpensive and disciplined labour from Konkan also contributed to the rapid population growth. The discovery of Bombay High oil and natural gas fields gave boost to its petro-chemical industry. Today, Mumbai is known as commercial capital of India backed by international and domestic airports, major sea ports and national road and rail terminals. Simillar is the case with other cities like Kolkata and Chennai which were established by the colonial rulers.

(ii) Availability of Natural Resources: The Chota Nagpur Plateau region has all along been a rocky and rugged terrains. This rainy and forested region has been a home of several tribes and was one of the sparsely populated parts of the country. However, a string of industrial towns and centres have sprung up over the past century soon after rich minerals such as iron-ore, manganese, limestone, coal etc. were found in unusual abundance and close to one another. The rich coal and iron fields have attracted heavy industries particularly iron and steel, heavy engineering, metallurgy and transport equipment industries. The region has also important super-power thermal stations from where power is supplied to far off areas. After liberalisation, many multi-nationals as well as national companies have been establishing their industries in large numbers.

Till now, it must be clear to you that why a particular area is sparsely populated whereas another area is densely populated. But, do you know the measurement of such concentration of population? Density is one such measurement. Let us discuss about density of population in the below given section.

21.3 DENSITY OF POPULATION

The size of population of different areas can be compared in many ways. One of the ways can be to compare the absolute size of the population. But it does not provide any idea about the relationship of population with the area or resource base of the country. This type of comparison is therefore not adequate. For example, population of Singapore is 4.2 million and that of Peoples Republic of China is 1,300 million. Indeed one is too small and the other is too big. Now take into consideration that the area of Singapore is just 630 sq. km; whereas China has an area of 9.5 million sq. km. This helps us to know how crowded Singapore is as compared to China. Therefore, the population of various countries are generally compared in terms of density of population. This is a method of comparing the human-land ratio of different regions. For this purpose, the population of a region is assumed to be distributed evenly in all its parts and the number of people per square kilometre is thus calculated. This is called arithmetic density of population or simply density of population.Hence, density of population is calculated by dividing the total population of a country or a region by the total area. Therefore the density of population is expressed as the number of persons per square kilometre.

Table 21.2: India: Density of Population

Census Year	Density of Population
1901	77
1911	82
1921	81
1931	90
1941	103
1951	117
1961	142
1971	177
1981	216
1991	274
2001	324
2011	382

Source: Census of India, 2011

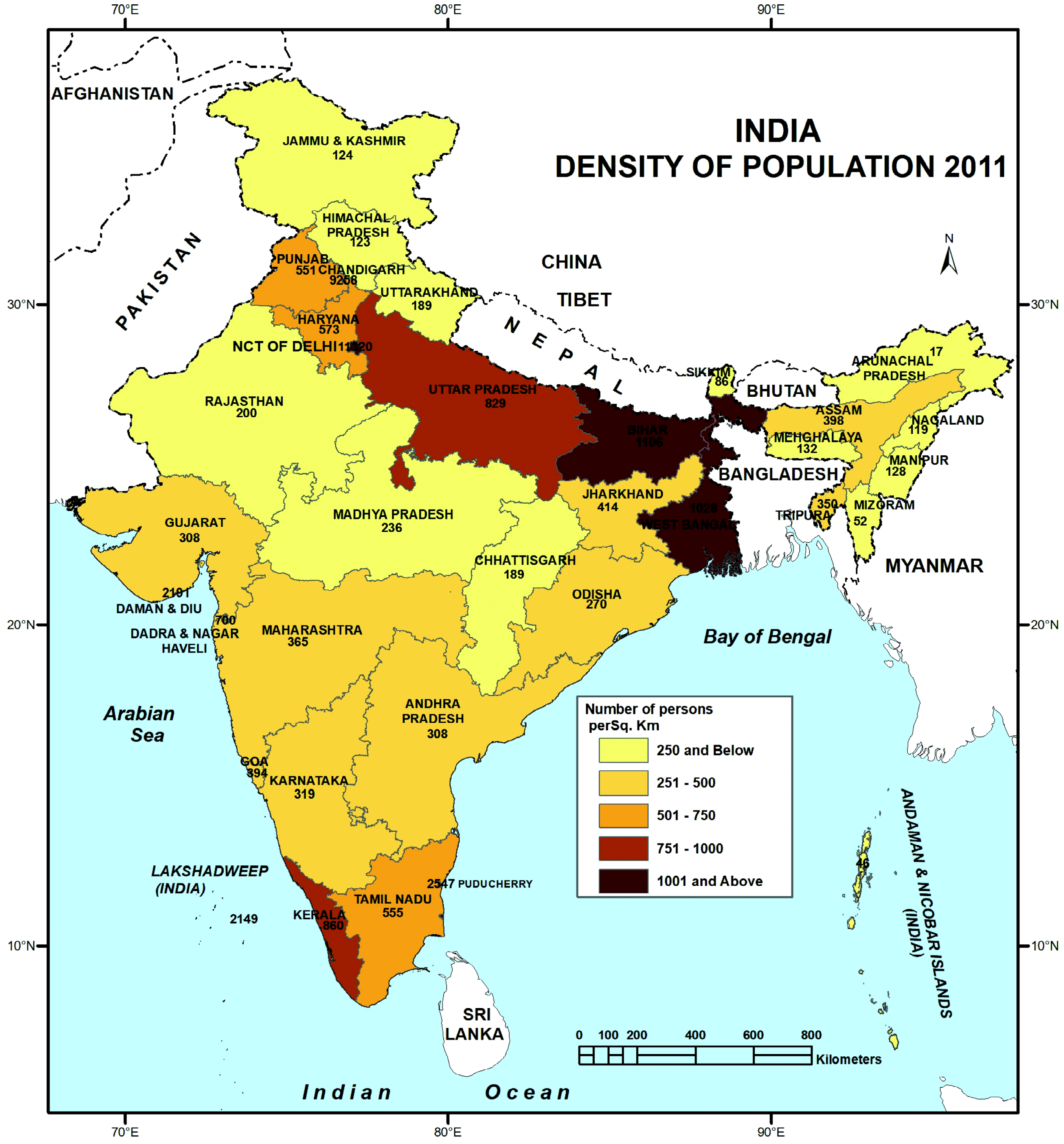


Fig. 21.5 India: Density of Population (2011)

According to 2011 census, the density of population in India is 382 persons per square kilometre. Over the last 110 years (1901 to 2011) density has increased about five times. It has increased from 77 in 1901 to 382 .in 2011. The increase has been very rapid after

independence. The density of population was 117 persons per square kilometre in Census 1951 (the first census conducted after independence).Since independence, density has increased about three times. When we say that the density of population of India is 382 persons per square kilometre, this does not mean that population is exactly 382 persons in each and every square kilometre.

In reality, the distribution of population in India is highly uneven. In the below given section, we will discuss spatial variation of density in India by taking state as an unit area of analysis.

Population Density: An Inter-State Level Analysis

Population density can be described or interpreted in a couple of ways depending upon its purpose. For finding out a broad distribution pattern, density is calculated on the basis of large units like states. If information is needed for more accurately, the smaller units like districts or even tehsils are used. Let us find out a broad pattern of population density in India by taking state as an unit area of analysis.

You will get a clear picture about the variations of density of Population in India from the fact that in Arunachal Pradesh the average number of population is only 17 persons per square kilometre, whereas it is 11,320 persons per square kilometre in National Capital Territory of Delhi as per 2011 census.Among the states, northern Indian States, Bihar (1106), West Bengal (1028) and Uttar Pradesh (829) have higher densities, while Kerala (860) and Tamil Nadu (555) have higher densities among the southern Indian states. States like Assam, Gujarat, Andhra Pradesh, Haryana, Jharkhand, and Odisha have moderate densities. The hill states of the Himalayan region and North eastern states of India (excluding Assam and Tripura) have relatively low densities while the Union Territories (excluding Andaman and Nicobar islands) have very high densities of population.

On the basis of availability of state level data, the density of population in India can be broadly divided into three zones: the areas of high density, moderate density and low density.

(i) **Areas of High Density:** In the map given above (Fig. 21.1) the areas having a density of population of more than 400 persons per square kilometre are included in this category. These areas have a high density due to fertile land and high amount of precipitation namely West Bengal, Bihar, andKerala. Can you identify the other states from the above given map that falls in this category? In these regions, a larger number of people can be provided sustenance per unit of area due to availability of fertile land which can produce more food for a large number of people. But the situation is entirely different in the case of Union Territories like Delhi, Chandigarh and Pondicherry. These regions are highly urbanised and offer job opportunities in industrial and service sectors. Thus we can say that the areas having fertile soil and those having good employment opportunities are densely populated. Find out which are the other states which have

high density of population.

(ii) Areas of Moderate Density: States and Union Territories in which the density of population ranges between 100 and 400 persons per square kilometre are categorised as areas of moderate density of population. They are Andhra Pradesh, Assam, Dadra & Nagar Haveli, Goa, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Rajasthan, Tripura, Chhattisgarh, Uttarakhand, Himachal Pradesh, Nagaland, Manipur and Meghalaya. This region includes largest part of the country in terms of area. Broadly speaking moderate density of population is characterised by the areas in which the agriculture is handicapped by rugged topography, lower amount of precipitation and paucity of water for irrigation. The scope for developing primary and secondary activities is quite large if the facilities are provided in this area. For example, at the time of independence Chhotanagpur region was a sparsely populated area but development in the field of mining and industries in this part of the country has been mainly responsible for moderate density of population in this region.

(iii) Areas of Low Density: All the remaining parts of India having a density of population less than 100 persons per square kilometre may be classified under this category. The States and Union Territories falling under this category include Arunachal Pradesh, Mizoram, Sikkim and Andaman and Nicobar Islands. Low density of population areas are characterised by rough terrain, low rainfall or unhealthy climate. Due to the above reasons the prospects of earning livelihood is low in these areas. Agriculture cannot be developed in too dry or cold areas. Uneven topography and poor agricultural resources put a limit on urbanisation and industrialisation. Therefore, the number of persons that can be supported per unit area is low in such regions. Difficulties exist not only in transport and communication in the hilly and mountainous areas but also in the overall levels of economic development. That is why the density of population in all these areas is low.

INTEXT QUESTIONS 21.2

1. Name three states having a high density of population

   (i) .... (ii) ....and (iii) ....

2. Name any three Union Territories in India which fall under the areas of high density of population

   (i) .... (ii) ....and (iii) ....

3. Name any three sates falling under the category of areas of low density of population.

Notes

(i) .... (ii) ....and (iii) ....

4. Name any one Union Territory having a low density of population

____

5. Fill in the blanks with most appropriate words given in the brackets.

   (a) Areas receiving ample precipitation and having fertile soils are likely to have a .... density of population. (high, moderate, low)

   (b) Areas suffering from droughts and having a rough terrain are likely to have a .... density of population. (high, moderate, low)

____

21.4 CHALLENGES OF GROWING POPULATION

Till now we have discussed size and growth of population. We have also discussed distribution of population, and factors affecting distribution of population. Looking at the huge population, there has been different views relating to the size and growth of population in the country. These views can be broadly grouped under two categories. These broad views are as follows:

1. Huge number of population act as a deterrent for the overall development of the country.

2. Number and growth of population is not the real problem

The first one is a pessimistic view whereas the latter one is an optimistic view. In the following paragraphs, we will discuss some of the main arguments for and against both views.

1. **Huge number of population act as a deterrent for the overall development of the country:** The extreme version of the population-as-a-serious-problem position attempts to attribute almost all the India's economic and social evils to excessive population growth. It has a negative impact on economic development by way of hampering various sectors like education, health, environment, food, economic growth. Similar view influenced the thinking of policy makers and planners in India till late 1970's. Various population control measures were implemented during various Five-Year Plans. After 1975-77, there was a shift in policy by changing the nomenclature from 'family planning' to 'family welfare'. But the real change in population policies were observed after International Conference on Population and Development (ICPD) was organised at Cairo, Egypt in 1994. This was fully reflected in National Population Policy, 2000.

2. **Number and growth of population is not the real problem:** The Problem is not population growth but 'Some Other Issue'. These are under development, inequitable distribution and access to resources, subordination of women etc. As long as the vast

Notes

majority of people in developing countries like India remain impoverished, uneducated, the large family will constitute to be the only real source of social security. The fact is that the developed countries, with less than 25 per cent of the world's population, consume almost 80 per cent of the world's resources. According to this argument, the developed nations should curtail, or cut back on their excessively high consumption standards, rather than having the less developed nations restrict their population growth. The latter's high fertility is really due to their low levels of living. It is this combination of rising affluence and extravagant, selfish consumption habits in rich countries and among rich people in poor countries which should be the world's major concern, not population growth.

There has been debates and discussion on the above mentioned issue both at national and international level. International Conference on Population and Development (ICPD) held at Cairo, Egypt in 1994 is a milestone in providing a new direction in population issues. In the below given section let us briefly discuss highlights of ICPD.

International Conference on Population and Development

International Conference on Population and Development (ICPD) was organised at Cairo, Egypt in 1994. ICPD is considered as a watershed in the history of population issues. It brought a paradigm shift in the field of population issues. Do you know what a paradigm shift is? In simple term it refers to shift in frameworks, strategies and approaches relating to population related issues. In this case the paradigm shift was from population control to creating an enabling environment focussing on improving quality of life that would help individuals to make a judicious decision. In other words, population was no longer refers to mere numbers, figures and statistics but about people and improving their quality of life. It was also agreed that no force, no coercion, no incentives and disincentives are required.Because, incentives and disincentives are either coercive or ultimately tend to be coercive and are in fact counterproductive. Coercion infringes upon human rights and inhibits human development. There was a consensus amongst all the 179 participating government representatives that the equality and empowerment of women is a global priority. It approached this not only from the perspective of universal human rights, but also as an essential step towards eradicating poverty and stabilizing population growth. A woman's ability to access reproductive health and rights is cornerstone of her empowerment.

A total of 179 governments including India signed the ICPD Programme of Action which include the following:

- Provide universal access to family planning and sexual and reproductive health services and reproductive rights;

- Deliver gender equality, empowerment of women and equal access to education for girls;
- Address the individual, social and economic impact of urbanization and migration;
- Support sustainable development and address environmental issues associated with population changes.

The ICPD Programme of Action (PoA) placed "individuals" in the centre of development with a focus on building pillars of Human Development, Human Rights, Gender Equity and Equality. The central theme of the ICPD was to forge a balance between population, sustained economic growth and sustainable development. The objective of the agreement reached at the Cairo Conference was to raise the quality of life and enhance well-being and to promote human development. The Programme of Action (PoA) rightly emphasized the need to integrate population concern fully into development strategies and planning, taking into account the interrelationship of population issues with goals of poverty eradication, food securityadequate shelter, employment and basic services (like health and education) for all.

Two fundamental changes have occurred in recent times in conceptualizing and implementing Population Policies. First is to ensure that Population Policies and Programmes address the root cause of high fertility such as persistent gender disparities in access to education, health, employment and other productive resources. Second is to expand existing Family Welfare Programme beyond contraceptive delivery to include a range of Reproductive Health Services with a greater emphasis on quality of care and individual's right. Now the focus has become broader and holistic and different in nature.

Two fundamental changes have occurred in recent times in conceptualizing and implementing Population Policies. First is to ensure that Population Policies and Programmes address the root cause of high fertility such as persistent gender disparities in access to education, health, employment and other productive resources. The second is to expand existing Family Welfare Programme beyond contraceptive delivery to include a range of Reproductive Health Services with a greater emphasis on quality of care and individual's right. Now the focus has become broader and holistic and different in nature. Earlier, Total Fertility Rate (TFR) and Contraceptive Prevalence Rate (CPR) used to be the fixation of most population programmes as they also served as indicators of success. ICPD replaced them with quality of care, informed choice, gender factor, women's empowerment and accessibility to a whole gamut of reproductive health services.

ICPD placed population, reproductive health and gender equality in a human rights-based framework. What does this mean? A human rights-based approach to programming differs from the basic needs approach. In this approach, it recognizes the existence of rights. It also

reinforces capacities of duty bearers (usually governments) to respect, protect and guarantee these rights. In a rights-based approach, every human being is recognized both as a person and as a right-holder. A rights-based approach strives to secure the freedom, well-being and dignity of all people everywhere, within the framework of essential standards and principles, duties and obligations. The rights-based approach supports mechanisms to ensure that entitlements are attained and safeguarded. Governments have three levels of obligation: to respect, protect and fulfil every right.

INTEXT QUESTIONS 21.3

1. In which country the International Conference on Population and Development (ICPD) was organised in 1994?
2. How many countries have signed the ICPD Programme of Action?
3. State any two points given in ICPD Programme of Action.

WHAT YOU HAVE LEARNT

Human resource is the most important resource in an area. It is the quality rather than quantity of this resource which is important for the economic development of a country India is the second most populous country of the world after China. The distribution of population is generally studied in terms of density. The density of population in India is not uniform. On the basis of density of population, India can be divided into three broad regions of high density, the areas of moderate density, and the areas of low density. The factors which affect density and distribution can be grouped into two categories. They are physical factors and socio-economic factors. The population of India has been increasing very rapidly since 1921 and the rate of growth has been increasing. The growth rate of population is determined by the birth rate, death rate and migration of an area. Like density and distribution, the growth rate is also not uniform throughout the country. Looking at the huge population, there has been different views relating to the size and growth of population in the country. These views can be broadly grouped under two categories. These broad views are as follows: (i) huge number of population act as a deterrent for the overall development of the country; and (ii) number and growth of population is not the real problem

TERMINAL QUESTIONS

1. What are the major trends in population growth in India? Discuss the factors responsible for it with suitable examples.
2. Discuss in brief the distribution of population in India. Outline some of the areas of high, moderate and low density of population.
3. Explain the Plan of Action suggested by International Conference on Population and Development.

ANSWERS TO INTEXT QUESTIONS

21.1

1. (a) (ii)
   (b) (ii)
2. Nagaland
3. Kerala

21.2

1. West Bengal, Kerala, Bihar, U.P. Punjab, Tamil Nadu and Haryana (Any three)
2. Delhi, Chandigarh, Pondicherry, Lakshadweep and Daman & Diu (Any three)
3. Sikkim, Mizoram, Arunachal Pradesh
4. Andaman and Nicobar Islands
5. (a) High
   (b) Low

21.3

1. Egypt
2. 179
3. • Provide universal access to family planning and sexual and reproductive health services and reproductive rights;

- Deliver gender equality, empowerment of women and equal access to education for girls;
- Address the individual, social and economic impact of urbanization and migration;
- Support sustainable development and address environmental issues associated with population changes. (Any 2)

22

POPULATION COMPOSITION

In the previous lesson, we studied about distribution, density and growth of population of India. We also looked into the causes and consequences of distribution and density of population. We pondered over the causes and consequences of rapid growth of population for the past hundred years. In this lesson we will study composition of Indian population along certain dimensions. Firstly, we would like to note the location and size of settlements in which people prefer to live and why they do so. This constitutes the rural and urban composition of population. Next we will find out if males and females are equal in number and more importantly in status. Age composition of Indian population and its implication would be yet another focal point of our inquiry. Then we would move away from purely demographic to socio-cultural dimensions of our population composition. This will help us to know the linguistic and religious composition of our society. Finally, we have a glance at scheduled caste and scheduled tribespopulation with regard to their numbers, location and distribution. Last but not the least important focal point of our study would be the levels of literacy in our country. All these analytical aspects would help us to look at our population not only as mere numbers but as a human resources as well.

OUTCOMES

After studying this lesson, learner:

- explains the rural-urban, Sex ratio and age composition of Indian population;
- describes the spatial and temporal change in levels of literacy;
- analyses the concentration of scheduled castes, scheduled tribes, religious and linguistic composition of population and
- describes recent population issues related to gender equality and reproductive health.

Notes

22.1RURAL-URBANCOMPOSITION

Population is divided into two parts-rural and urban on the basis of the size and occupation of settlements. The rural population consists of small sized settlements scattered over the countryside. Urban population is one that lives in large size settlements i.e. towns and cities. However, more importantly this division is based on occupational structure. In India, rural area is defined as one where three-fourths or more of its population is engaged in primary occupations such as farming, animal rearing, forestry, fishing, quarrying etc. On the other hand, urban area is one where three-fourths or above of its population is engaged in non-agricultural activities such as manufacturing, trade, transport, communication, banking and social services like health, education, administration etc.

Table 22.1 Rural and Urban Population in India (1911-2011)

Census year	**Percentage of total Population**	
	Rural	Urban
1901	89.2	10.8
1911	89.7	10.3
1921	88.8	11.2
1931	88.0	12.0
1941	86.1	13.9
1951	82.7	17.3
1961	82.0	18.0
1971	80.1	19.9
1981	76.7	23.3
1991	74.3	25.7
2001	72.2	27.8
2011	68.8	31.2

Source: Census of India

The total population of India spreads over more than 6, 40, 867 villages and 7,935 towns. India, proverbially, is considered to be a country of villages. Even today, about 69% of the

total population of India lives in villages. But the proportion of rural population has been decreasing in each successive census (See Table 22.1). Consequently the proportion of urban population to total population has been increasing slowly but steadily. It was as low as 10.8% in 1901 and rose to 31.2% by 2011. The question arises why is it so? It is because the rate of growth of urban population is higher than that of rural population. The Growth in Urban population is significantly higher at 31.8% that in Rural population (12.18%) during 2001-11. Growth in Rural Population in India is steadily declining since 1991. However all this growth is not a result of only the natural increase of population.In fact, much of the growth of urban population is due to high rate of migration of people from rural to urban areas. Very often limits of municipal or city Corporation areas are extended to cover neighbouring villages or suburbs.

Half of the total urban population of India lives only in five states. These five states are Maharashtra, Uttar Pradesh, Tamil Nadu, West Bengal and Andhra Pradesh. Gujarat, Karnataka, Madhya Pradesh, Bihar, Rajasthan and Union Territory of Delhi, have about 32 per cent of urban population of the country. Rest of the urban population (about 18%) is spread over the remaining states and Union Territories

According to 2011 census, 53 cities have more than 1000000 population each. They are called the metropolitan or million plus cities. These 53 metropolitan cities alone account for 37.8% of the total population. This highly rapid growth of metropolitan cities will brings several problems like supply of housing, electricity, water, school, dispensaries, ration shops etc. Let us now find out the distribution of these metropolitan cities in India.

All the 53 metropolitan cities are arranged in terms of descending orders of population. These are Mumbai, Delhi, Kolkata, Chennai, Bangalore, Hyderabad, Ahmedabad, Pune, Surat, Jaipur, Kanpur, Lucknow, Nagpur, Ghaziabad, Indore, Coimbatore, Kochi, Patna, Kozhikode, Bhopal, Thrisur, Vadodara, Agra, Vishakhapatnam, Mallapuram, Thiruvananthapuram, Ludhiana, Kanur, Nasik, Vijaywada, Madurai, Varanasi, Meerut, Faridabad, Rajkot, Jamshedpur, Srinagar, Jabalpur, Asansol, Vasai-Virar, Dhanbad, Allahabad, Aurangabad, Amritsar, Jodhpur, Ranchi, Raipur, Kolam, Gwalior, Durg-Bhilainagar, Chandigarh, Tiruchirapalli, and Kota.

Fig. 22.1 India: Major Metro Cities

INTEXT QUESTIONS 22.1

1. Fill in the blanks with suitable words from those given in the bracket

(Secondary and tertiary, increasing, 53, lower, primary)

(a) The growth rate of rural population is ------than the growth rate of urban population in India.

(b) The rural population is mainly engaged in ----- activities whereas the urban population is primarily engaged in ----- activities.

(c) Proportion of urban population has been --- since 1921.

(d) Altogether there are --- "million cities".

22.2 SEX-RATIO

Sex Ratio refers to the number of females per thousand males of an area. According to the Census of India 2011, there are only 943 females per thousand males. So sex composition in India is unfavourable. It means there are less number of females than the number of males. When the number of females is more than the males it is said to be favourable. If we analyse the data over a period of 100 years (1911-2011), it has been observed that there has been steady decline of sex ratio in the country except some marginal increases in the 1951, 1981, 2001 and now in 2011.

Table 22.2: Sex Ratio in India 1911-2011

Census Year	Sex Ratio
1911	964
1921	955
1931	950
1941	945
1951	946
1961	941
1971	930
1981	934
1991	927
2001	933
2011	943

Source: Census of India

Notes

As far as states are concerned only Kerala has favourable sex ratio (1058). It has the highest sex ratio in the country. The lowest sex ratio among states is found in Haryana (877). Among the Union Territories, Pondicherry has the highest sex ratio in the country with (1001) females per thousand males, whereas the lowest sex ratio is found in Daman and Diu where there was 618 females per thousand males. The significant trend with regard to the sex ratio in the country is that it has been a steadily declining except some marginal increases in the 1951, 1981, 2001 and now in 2011 censuses.

Why is there a decline in the sex ratio in India? The major reasons for the declining sex ratio in India are the higher rate of maternal mortality and a high child mortality among the female children. These two causes are related to the comparatively lower status of the women in our society. Apart from this our socio-cultural values and beliefs like male preference in our society are responsible for the declining sex ratio. The female mortality rate is likely to be reversed with the improving status of the women and also due to better health facilities and education particularly of the females. The improved medical facilities have helped in checking the rate of child mortality and the deaths of mothers during child birth.

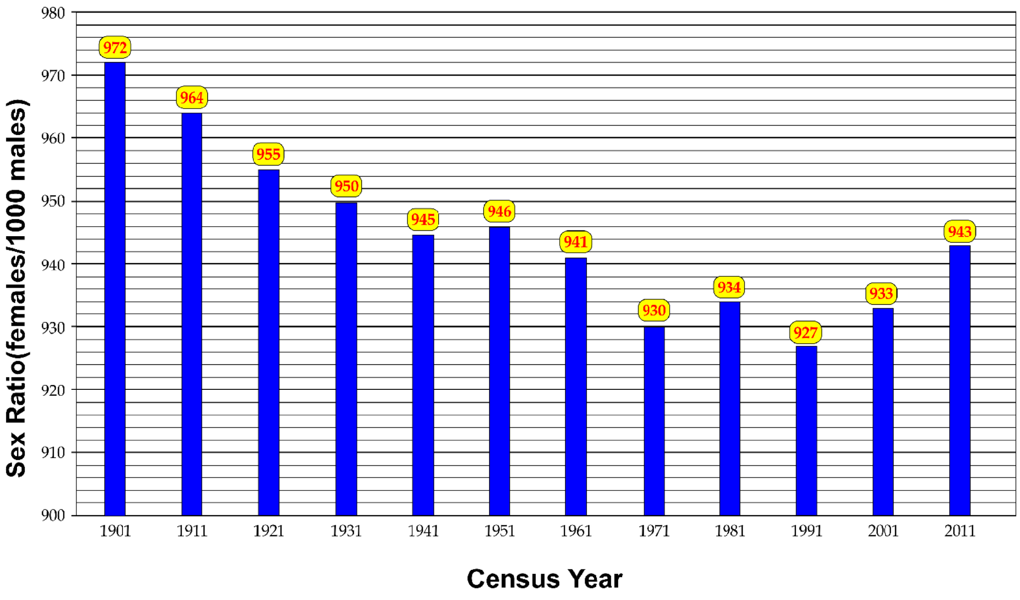


Fig. 22.2 India: Trends of Sex Ratio 1901-2011

Gender Equity, Equality and Empowerment of Women

Gender equity and equality is a human right. Women are entitled to live with dignity and with freedom from want and from fear. Gender equality is also a precondition for advancing development and reducing poverty: Empowered women contribute to the health and productivity of whole families and communities, and they improve prospects for the next generation. Still, despite solid evidence demonstrating the centrality of women's empowerment to realizing

Notes

human rights, reducing poverty, promoting development and addressing the world's most urgent challenges, gender equality remains an unfulfilled promise.

Reproductive Health and Reproductive Rights

Reproductive health is a state of complete physical, mental and social well-being in all matters relating to the reproductive system and to its functions and processes. It implies that people have the capability to reproduce and the freedom to decide if, when and how often to do so. Implicit in this is the right of men and women to be informed and to have access to safe, effective, affordable and acceptable methods of family planning of their choice, as well as other methods of their choice for regulation of fertility, which are not against the law, and the right of access to health-care services that will enable women to go safely through pregnancy and childbirth. Reproductive health care also includes sexual health, the purpose of which is the enhancement of life and personal relations.

Reproductive rights embrace certain human rights that are already recognized in national laws, international human rights documents and other relevant UN consensus documents. These rights rest on the recognition of the basic right of all couples and individuals to decide freely and responsibly the number, spacing and timing of their children and to have the information and means to do so, and the right to attain the highest standard of sexual and reproductive health. They also include the right of all to make decisions concerning reproduction free of discrimination, coercion and violence. Full attention should be given to promoting mutually respectful and equitable gender relations and particularly to meeting the educational and service needs of adolescents to enable them to deal in a positive and responsible way with their sexuality.

Reproductive health-care programmes should be designed to serve the needs of women, including adolescents, and must involve women in the leadership, planning, decision-making, management, implementation, organization and evaluation of services. Innovative programmes must be developed to make information, counselling and services for reproductive health accessible to adolescents and adult men. Such programmes must both educate and enable men to share more equally in family planning, domestic and child-rearing responsibilities and to accept major responsibility for the prevention of STDs

INTEXT QUESTIONS 22.2

Answers the following questions in brief:

(a) Name the state having the highest sex ratio in India

(b) Name the state having lowest sex ratio in India

Notes

(c) What is the sex ratio of India according to Census of India, 2011?

(d) Define sex ratio.

22.3 AGE COMPOSITION

Age-sex pyramid refers to the composition of population in terms of the age and sex of people. It gives an indication regarding the growth rate of population and the nature of population in terms of working and non-working sections. As per the census of India 2011, children up to 14 years of age account for 30.80% of the total population. The age group of 15-59 years accounts for 60.7% of total population and the age group of 60 years and above for 8.4% of population. The age structure has been undergoing some gradual changes during the recent decades. One of the trends is that proportion of the younger population i.e. in the age group of 0-14 years is declining and the percentage of persons on the working age group, i.e. 15 to 59 age group as well as old age population i.e. 60 years and above is increasing. But in 2001 Census, the percentage of persons in the age group of 15-59 has increased from 56.9% in 2001 Census to 60.7 % in 2011 Census. However, the proportion of people in old age group has increased from 7.4% in 2001 to 8.7% in 2011 census. The proportion of young population i.e. 0-14 years declined from 35.3% in 2001 census to 30.80% in 2011 census (Fig.22.3).

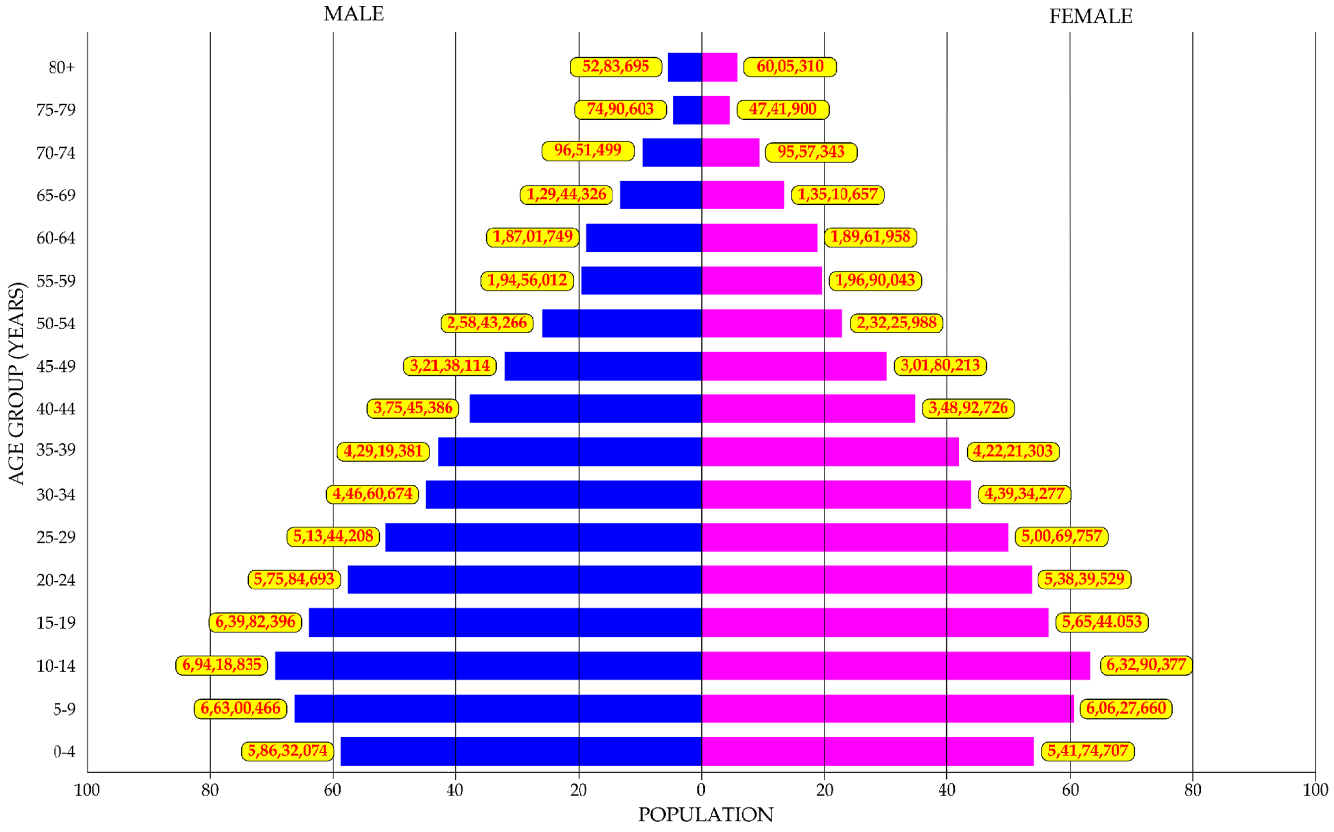


Fig. 22.3 India: Age-Sex Composition 2011

DEMOGRAPHIC DIVIDEND

Have you heard this term? Now a day's planners, policy makers, political leaders and academics have been talking about this for quite some time. It has been clear from the discussion in the previous section that India has been adding large number of population each year in terms of absolute number. If you look at their age composition, you will find that a significant proportion of them are youth population (15-35 years). According to 2011 India there were 62.5 per cent population in the age group 15-59. As you know this is the active working population. This increase in share of active working population helps in reaping the benefits of 'Demographic Dividend'. In simple terms demographic dividend can be expressed as a limited time 'window of opportunity' for rapid economic growth. However, the challenge before the nation is to make them skilled human resource so that they can contribute significantly for nation building in general and improve their standard of living in specific.

22.4 LINGUISTIC COMPOSITION

India has also linguistic diversity like physical environment. The languages spoken and their dialects number is in hundreds. In 1961 census, 1652 languages were listed as mother tongues in India. Out of these only 23 languages together accounted for 97% of total population of the country. Out of these 23 numerically major languages, Constitution of India recognizes only 22 languages besides English in the Eighth Schedule of the Constitution. These languages are Assamese, Bengali, Hindi, Telugu, Tamil, Malayalam, Kannada, Marathi, Gujarati, Oriya, Punjabi, Kashmiri, Sanskrit, Konkani, Sindhi, Nepali, Manipuri, Urdu, Bodo, Dogri, Maithili and Santhali. Out of these above mentioned 22 languages, Hindi is spoken by most of the people whereas Sanskrit is spoken by the least. Of these languages, 14 were initially included in the Constitution. Sindhi language was added in 1967. Thereafter three more languages viz., Konkani, Manipuri and Nepali were included in 1992. Subsequently Bodo, Dogri, Maithili and Santali were added in 2004.

The languages also vary slightly in terms of the meaning of different words and their pronunciation. Thus the people speaking one particular languages speak it with some difference in vocabulary and pronunciation from one place to the other. Such variations in the way of speaking of a language lead to emergence of dialects of language. Thus, a dialect is something akin to a part of some language and they can be thought as regional language also. Some of the examples of the dialects of Hindi are Rajasthani, Harayanavi, Bhojpuri or Poorvi dialects etc. Language is an important constituent of culture and various languages and their dialects are spoken in different parts of India. It makes Indian culture rich and diversified. Also, the languages have an almost complete regional identity in the country and the distribution of major languages has been considered as a basis for re-organization of states after independence.

On the basis of numerical strength, India can be divided into twelve principal linguistic regions. So linguistic region is an area in which most of the people speak a common language. The languages forming linguistic regions in India are Kashmiri, Punjabi, Hindi/Urdu, Bengali, Assamese, Oriya, Gujarati, Marathi, Tamil, Telugu, Kannada and Malayalam.

CLASSIFICATION AND DISTRIBUTION OF INDIAN LANGUAGES

Though all the languages spoken in India seem to be different from each other, they can be grouped into four linguistic families on the basis of their roots and genesis. The four linguistic families are: Austric, Dravidian, Sino-Tibetan and Indo-European Family.

(i) The speeches of the Austric family are spoken by tribal people in Meghalaya, Andaman & Nicobar Islands and in parts of Central Indian tribal belt, especially in the districts of Santhal Praganas, Ranchi and Mayurbhanj.

(ii) The languages and dialects of Sino-Tibetan family are spoken by tribal people in North-Eastern region of the country and in the Sub-Himalayan region in the north and North West. These languages are spoken by people living in the Union Territory of Ladakh, parts of Himachal Pradesh and Sikkim also.

(iii) The speakers of the languages of Dravidian family are more numerous in southern part of India. Tamil Nadu, Andhra Pradesh, Karnataka and Kerala are the states Union Territory of Pondicherry where these languages are spoken by the majority of population. A large number of tribal living in peninsular plateau region also speak speeches of this family.

(iv) The speaker of the languages of Indo-Aryan family are concentrated more in the northern and central parts of the country. The entire North Indian plain is inhabited by the speakers of this family. Maharashtra and Madhya Pradesh also have large population of speakers of these languages.

The proportion of the speakers of languages of different families in the total population varies significantly. While the Indo-Aryan family languages are spoken by more than 70% of the people, the Sino-Tibetan languages are spoken by only about 0.85 percent of the population and Dravidian languages are spoken by about 20 percent of the people.

INTEXT QUESTIONS 22.3

Fill in the blanks with the most appropriate words out of those given in the brackets:

1. (a) One of the languages belonging to the Austric Family of languages is ------- (Santhali, Hindi, Bengali)

Notes

(b) Hindi is a languages belonging to the --- family of languages (Dravidian, Aryan, Austric)

(c) Speakers of Austric languages are concentrated primarily in --- - (tribal areas of central India, western Himalayas, Konkan region

22.5 RELIGIOUS COMPOSITION

Indian society has a large number of religious communities. But, broadly there are seven major religions. The majority of people follow one of these seven major religions. These are Hinduism, Islam, Christianity, Jainism, Budhism, Sikhism and Zoroastrians. Hindus are the largest religious community in India .

Table 22.4 Population by Religion in 2011 Census

S. No.	Religion	In Crore (%)
1	Hindu	96.63 (79.8%)
2	Islam	17.22 (14.2%)
3	Christian	2.78(2.3%)
4	Sikh	2.08 (1.7%)
5	Buddhism	0.84 (0.7%)
6	Jain	0.45 (0.4%)
7	Other Religions and Pursuations	0.79 (0.7%)
8.	Religion Not Stated	0.25 (0.2%)

According to 2011 census, 79.8% percentage of population follow Hindu religion. Followers of this religion are more concentrated in the northern plains and the northern parts of the plateau region. However they are numerous in all parts of the country except a few north-eastern states and union territory of Lakshadweep. But the distribution of the other religious communities is less continuous and there are only some pockets in which they have larger concentration.

The largest number of Muslim population is in Uttar Pradesh followed by West Bengal and Bihar. But the Muslim population make a large proportion of the total population in Jammu and Kashmir and Union Territory of Lakshadweep. Apart from these above mentioned states and Union Territory, other states where Muslims have significant presence (more than national average) are Assam and Kerala. If we look at spatial distribution, then it is observed that most

of these states stretch over Northern Plains except Kerala and Jammu and Kashmir.

The largest concentration of Christians is found in the state of Kerala followed by Tamil Nadu and Andhra Pradesh. But if we look at the proportion to total population, then it is found in some of the north eastern states namely Mizoram, Meghalaya and Nagaland. As far as Sikhs are concerned more than ¾th Sikh population are found in Punjab alone. Besides Punjab, neighbouring districts of Haryana and Rajasthan also have concentration of Sikh population. Apart from these states, Terrai region of Uttarakhand and National Capital Territory of Delhi have significant number of Sikh population. As far as Buddhists and Jains are concerned, Maharashtra has the largest number of population belong to both the religion. Apart from Maharashtra, traditional pockets of Buddhists are Union Territory of Ladakh, Dharamsala (Mcleodganj) and surrounding districts of Himachal Pradesh, Sikkim, Arunachal Pradesh and Tripura. Similarly, besides Maharashtra, Jains have significant presence in the states of Rajasthan, Gujarat, Madhya Pradesh and Chhattisgarh.

INTEXT QUESTIONS 22.4

1. In which part of India do most of the Zoroastrians live?
2. In which states do most of the Indian Christians live?
3. Name one state having a large concentration of Muslim population of India.
4. In which states of India do most of the Indian Budhists live?

22.6 SCHEDULED CASTES AND SCHEDULED TRIBES COMPOSITION AND DISTRIBUTION

The Constitution of India recognises a number of castes and tribal groups. These castes and tribes are called Scheduled Castes (SC) and Scheduled Tribes (ST) respectively. They are the major constituents of the population of India. According to the census of India 2011 Scheduled Castes and Scheduled Tribes constitute 16% and 8.2% respectively. Their distribution is very uneven throughout the counry.

(A) Scheduled Castes

Numerically they have the largest concentration in Uttar Pradesh followed by West Bengal and Bihar. Mizoram has the least SC population. The state of Nagaland and Union Territories of Lakshadweep and Andaman & Nicobar Islands do not have any notified SC Population. In terms of the proportion of the total population of a state they are most numerous in Punjab where they account for more than 28.85% percent of its total population followed by Himachal Pradesh (24.7%) and West Bengal (23.3%). The Scheduled Castes are by and large landless

agricultural labourers, cultivators with small land holdings and small commodity producers or artisans. Due to the association with agricultural activities, their main concentrations are found in the alluvial and coastal plains of the country. That is why, the major concentrations are found in the states like Punjab, Uttar Pradesh, West Bengal, and Bihar. On the other hand the hilly and forested tracts and the tribal belt of the central and north east India have only a small population of the Scheduled Castes. The analysis at districts level pattern leads to the identification of the following three zones.

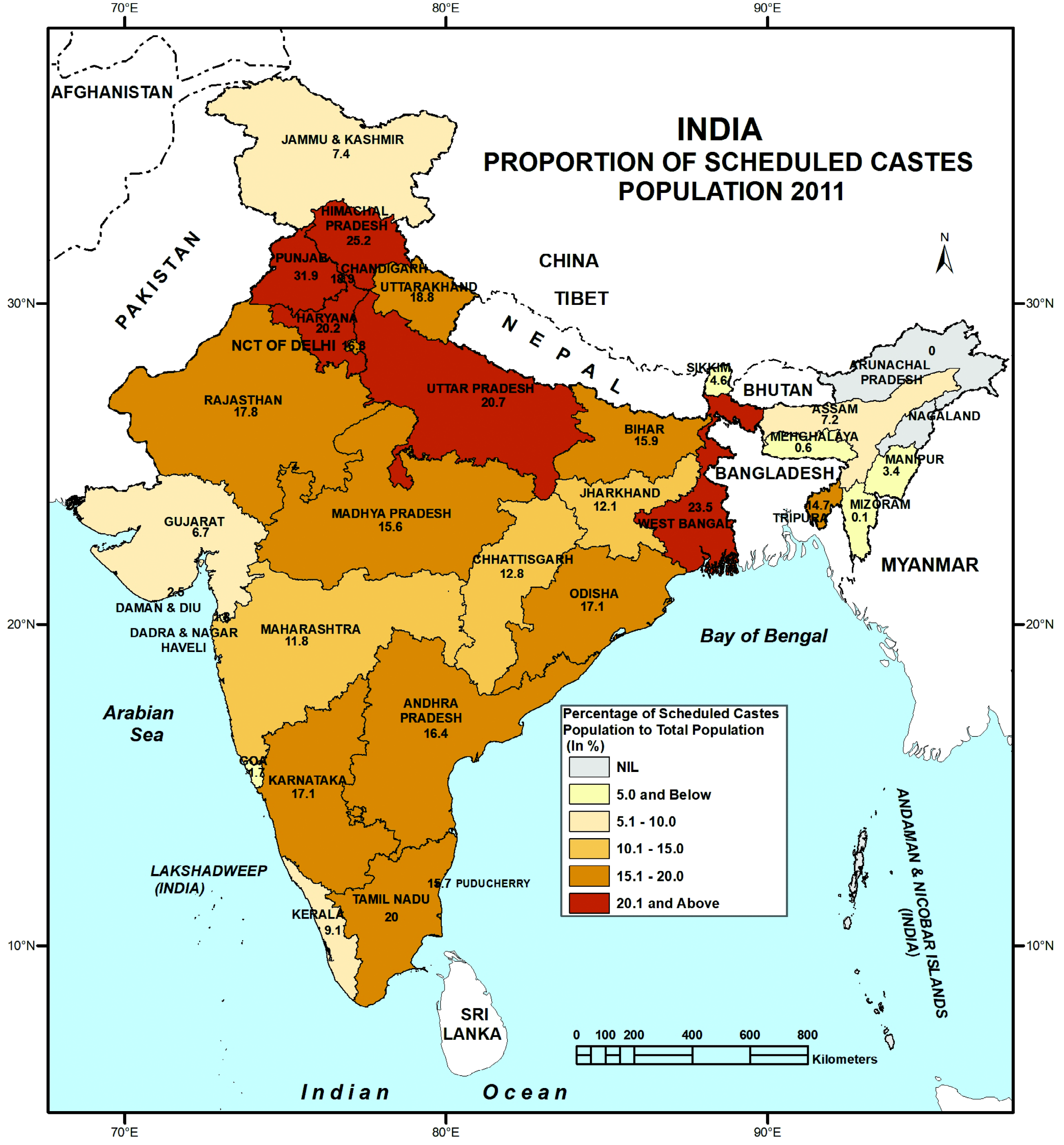


Fig. 22.2 India: Scheduled Caste Population

(i) Areas of High Concentration: There are two major areas with high concentration of Scheduled Castes. They are Indo-Ganga plain and the eastern coastal plain. Both these plains are endowed with fertile soil, adequate water supply and climate suited to the cultivation of a large variety of crops. These opportunities help to develop intensive agriculture which supports a large population.

(ii) Areas of Medium Concentration: The Scheduled Castes are moderately concentrated in the districts adjoining the zone of high concentration which has already been discussed above.

(iii) Areas of Low Concentration: Low concentration of Scheduled Castes is found in the central Vindhyas, Chhotanagpur region, the western dry region of Rajasthan, the hilly tracts of the North-East and the coastal parts of Karnataka and Maharashtra.

(B) Scheduled Tribes

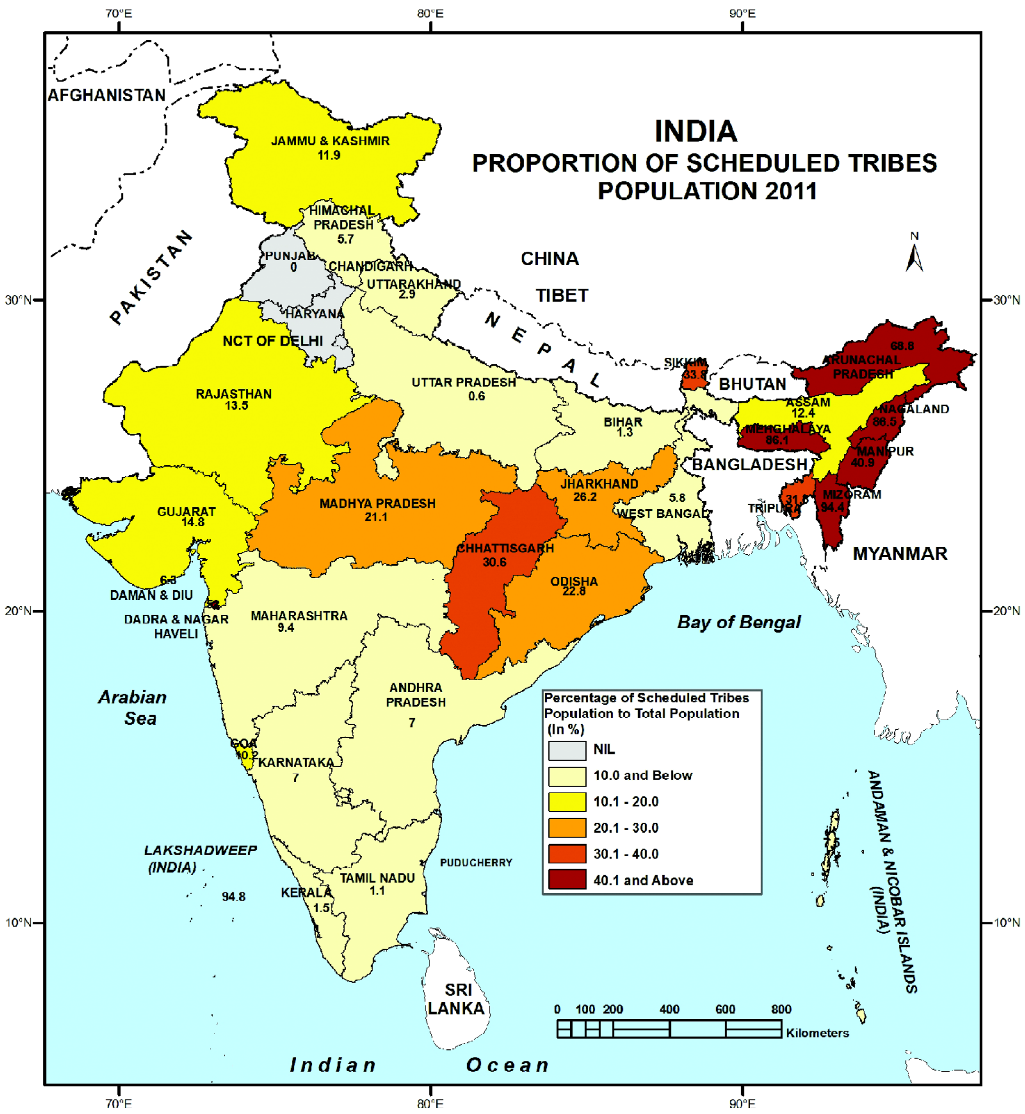


Fig. 22.3 India: Scheduled Tribe Population

The tribal people have a number of distinct characteristics which set them apart from the rest of the people. Generally, they live in isolation in the forested and hilly regions and they profess very old religious beliefs. Most of these groups are illiterate and do not have script of their languages. Most of them belief in super natural powers and super natural beings. The Scheduled Tribes are not uniformly distributed all over the country.

There are three main regions in which most of their population lives. These regions are

(i) the Central Indian belt comprising parts of Rajasthan, Gujarat, Madhya Pradesh, Chhatisgarh, Jharkhand, Orissa and West Bengal,

(ii) the North-Eastern region comprising the hilly areas of Assam, Meghalaya, Manipur, Mizoram, Nagaland, Tripura and Arunachal Pradesh and

(iii) the southern region comprising the hilly tracts of Tamil Nadu, Andhra Pradesh and Andaman & Nicobar Island.

It is evident from the above discussion and also from the map that the tribal population of India is more concentrated in a few specific regions. It will also be clear after a close study of the map that most of the tribal people live in the forested and hilly regions and areas of lower agricultural productivity. Most of these areas suffer from natural difficulties like rough terrain and climatic difficulties and the level of economic development in all these regions is very low. The natural resources have not been developed much and there is little development of means of transport and communication and this factor is also responsible for the low levels of development. Sometimes, it is thought that the levels of economic development in areas of tribal population is low because these areas are inhibited by the tribal people. This, however, is not true. These areas suffer from lower levels of development party due to in hospitable life in these regions is difficult and therefore these areas are occupied by the tribal people. In fact the tribal people originally did not settle in these areas of harsh environmental conditions by their own choice. They were rather pushed by the expanding modern civilization into these areas. Under the pressure of the successive invaders and the migrants, the earlier settlers of the country who could not fight with new powerful comers had to migrate into remote areas to save their cultural identify.

22.7 LITERACY

Literacy is generally defined as a person's ability to read, write and able to understand as well as to do some simple calculation. Despite this liberal definition, the rate of literacy in India is not very high. According to the Census of India 2011, the average literacy rate in India is 74.04 per cent. This percentage does not include the population below 7 years of age-group. The rate of literacy varies a great deal from one part of the country to the other. On the one hand, it is the state of Kerala having literacy rate as high as the 94.00 percent and on the other extreme is the state of Bihar, where this rate is only 61.80 per cent. In the Union Territories,

Lakshadweep has the highest rate of literacy where it is 91.85 percent and the lowest rate is in Dadra & Nagar Haveli (76.24 per cent).

The rate of literacy varies between males and females also. The average rate of literacy among the males in India is 82.14 per cent which is higher than the females (65.46 per cent). Kerala has the distinction of highest literacy among both, males and females (96.11 and 92.07 per cent respectively), whereas Bihar has the lowest literacy rate among both males and females (71.20 and 51.50 percent respectively). Though the rate of literacy in India is moderate, it is increasing in each successive census. In 1911 it was less than 6 percent and it could rise to only about 16.7 percent by1951. The most noteworthy progress in this regard has been made after 1951 census. In 1961, the literacy rate was about 24 percent which rose to 74.04 percent by 2011. The most significant development in this regard has been the rate of increase in female literacy. The proportion of literate among the females was only 1.1 percent in 1911 which has increased to 65.46 percent in 2011. To a great extent, this is a result of the policies of the government, emphasising upon the universalisation of Elementary Education. The extended facilities of schools in the rural areas have helped considerably in raising the literacy rate in the country, especially among the females.

Though the literacy rate is increasing percentage wise in successive censuses, the number of illiterate is also increasing in absolute number in each successive census. For the first time in 2001 census, there is a decline in number of illiterates in comparison to previous census i.e. 1991. However their number is still very high. To solve this problem, Government has taken up various programmes like National Literacy Mission, Sarv Shiksha Abhiyan, New India Literacy Programme etc.

INTEXT QUESTIONS 22.5

Fill in the blanks with the most appropriate words out of those given in brackets.

1. (a) One of the areas of large concentration of tribal population in India is ___________________. (Punjab, Haryana, Jharkhand)

   (b) Scheduled castes population constitute the most significant proportion of the total population in the state of ____________________. (Uttar Pradesh, Bihar, Punjab)

   (c) According to the census of India 2011, the average literacy rate of India is ____________ percent. (65.38, 74.04, 68.01)

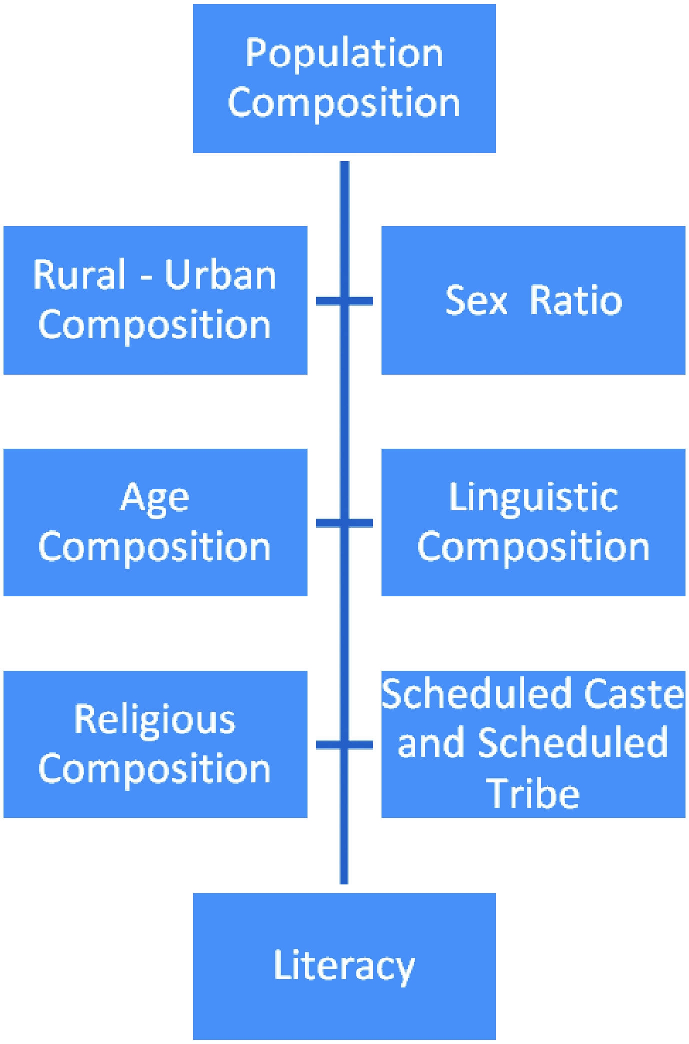
2. Name any two programmes taken by Government of India to increase literacy rate.

   (i)_________________________ (ii)_________________________

3. Which state having highest literacy among both males and females?

____

WHAT YOU HAVE LEARNT



TERMINAL QUESTIONS

1. Discuss in brief the following characteristics of Indian population.

   (a) age structure

   (b) rural-urban ratio and

   (c) sex ratio.

2. Give an account of literacy in India. .
3. What are the factors responsible for the decline in sex ratio? Discuss in brief.
4. Discuss the regional distribution of tribal population in India.
5. To which major linguistic families do most of the Indian languages belong? Give a brief account of the distribution of various linguistic families in the country

ANSWERS TO INTEXT QUESTIONS

22.1

(a) lower
(b) primary, secondary and tertiary
(c) increasing
(d) 53

22.2

(a) Kerala
(b) Haryana
(c) 943
(c) It refers to the number of females per thousand males in an area.

22.3

(a) Santhali
(b) Aryan
(c) Tribal areas of central India

22.4

1. In and around Mumbai.
2. TamilNadu, Kerala, Andhra Pradesh & North-Eastregion
3. Uttar Pradesh
4. Maharashtra & Arunachal Pradesh

22.5

1. (a) Jharkhand (b) Punjab
   (c) 74.04
2. National Literacy Mission, Sarva Siksha Abhiyan, New India Literacy Programme etc.
3. Kerala

23

HUMAN DEVELOPMENT

Whenever, we think about development, we normally tend to think about the material and economic development. Materials may include house, landed property, motor vehicle, jewellery etc. Again all these material assets are converted in terms of money, whenever or wherever the need arises. Till today, the entire world is divided into two groups of countries - developed and developing. This classification is mostly based on level of economic development. Though this trend is still continuing but a change in thinking about development was introduced.There has been a change in emphasis on measurement of development from purely economic dimension to a composite socio-economic dimensions. From 1990 onwards, United Nations Development Programme (UNDP), each year calculate Human Development Index (HDI) and publish as a report which is known as Human Development Report (HDR). This report, is published each year in which almost all the countries are placed under three categories, high, medium and low based on the defined parameters.

In this lesson, we will learn about the concept and process of measuring human development index. We will also find out India's position among the various countries in the world. Simultaneously, we will also analyse position of various states of India as far as human development index is concerned. At the end, we will suggest certain measures to improve human development in our country.

OUTCOMES

After studying this lesson, the learner:

- defines the term human development and human development index;
- describes the regional patterns of human development; and
- highlights the need for improvement in inclusive human development.

23.1 CONCEPT OF HUMAN DEVELOPMENT

Do you know who coined the term 'Human Development'? In 1990 economists Dr. Mehbub Al Haque introduced the concept of Human Development. This concept was used for the construction of Human Development Index. In the inaugural issue of Human Development Report - 1990 published by United Nations Development Programme (UNDP), the authors defined human development as "a process of widening people's choices as well as raising the level of well-being". Human development concept is based on the idea of "development as a freedom". It is about building human capabilities - the range of things they can do and what they can be. Individual freedoms and rights matter a great deal. But these freedoms and rights are restricted for some because they are poor, illiterate, discriminated against, threatened by violent conflict etc. To achieve this there is a need for re-orientation of our process of development. In other words, development must revolve around the people, not people around the development.

To know more detail about the concept, let us refer to the writing of MahbubulHaq whopropounded this concept. In his book titled "Reflections on Human Development" discussed about the four pillars of human development. These are equity, sustainability, productivity and empowerment. Let us discuss them briefly.

1. **Equity:** Can you be able to elaborate the meaning of equity. In simpler terms it refers to equal opportunity to everyone without any discrimination of gender,caste,income and social influence. Can you now distinguish between equity and equality?

2. **Sustainability:** The second pillar is sustainability. It means providing continuous access to and availability of resource by keeping in mind the future generation. In other words, all future generations should have access to minimum resources utilized by today. You will read in details about sustainability and sustainable development in the next module.

3. **Productivity:** The third pillar according toMahbubulHaq is productivity.It refers to constantly improving capabilities of human resources for delivery their work.Ultimately people are the real wealth for any nation,if they are more skilled their values certainly will go up.

4. **Empowerment:** The fourth and final pillars of human development is empowerment. Now a days you might be hearing about various schemes by state governments and government of India for socio-economic empowerment of disadvantaged sections of the society. What does this mean? It refers to a type of power which generates choice of freedom in human beings.Good governance and people oriented policy are required to empower human developments.

If you carefully read the definition of human development given in the beginning of this section you can found reflection of these four concepts in the statement.

After knowing the concept of human development and its four pillars, can you differentiate between the concept economic development and human development? The basic difference between economic development and human development is that economic development entirely focuses on the increase of income whereas the human development believes in expanding and widening of all aspects of human life be it economic, social, political, cultural, etc. In economic aspect human development is one of the essential elements. The basic idea behind this is that it is the use of income and not theincome itself that decides the human choices. Since, the real wealth of a nation is its people, therefore, the goal of development should be the enrichment of human life.

Need for Human Development: After knowing the concept of human developmentand , you might be thinkingthat the need for creating another concept to measure the progress in development. Paul Streeten, a development economist identified six reasons in favour of the human development. The reasons are as follows:

1. The ultimate purpose of the entire exercise of development is to improve the human conditions and to enlarge people's choice.
2. Human development is a means to higher productivity. A well-nourished, healthy, educated, skilled alert labour force is the most productive asset. Therefore investments in these sectors are justified on ground of productivity.
3. It helps in reducing the rate of growth of population.
4. Human development is friendly to the physical environment also. Deforestation, desertification and soil erosion decline when poverty declines.
5. Improved living conditions and reduced poverty contribute to a healthy civil society and greater social stability. 6. Human development also helps in reducing civil disturbance in the society and in increasing political stability.

After studying the concept of human development, let us understand the measurement of human development in section 23.2.

23.2 MEASUREMENT OF HUMAN DEVELOPMENT

To measure the levels of human development, a set of indicators were proposed under three dimensions. Therefore, Human Development Index (HDI) is a composite index that measures the average achievements in a country in three basic dimensions of human development. These basic dimensions are a long and healthy life, knowledge and a decent standard of living. The above mentioned dimensions are measured by the following indicators.

Notes

1. A long and healthy life is measured by life expectancy at birth

2. Knowledge is measured by mean year of schooling and expected year of schooling

3. A decent standard of living is measured by GDP per capita (Adjusted do purchasing power parity in US dollar)

But we should know that the purpose of its construction is not to give a complete picture of human development rather to provide a measure which goes beyond the traditional measurement of development i.e. income. Therefore, HDI is a barometer for changes in human wellbeing and for comparing progress in different regions.

Apart from Human Development Index (HDI), the other four indicators of human development have been selected which were used by the Human Development Report for the last three decades. These are:

(i) Human Poverty Index for developing countries (HPI-1)

(ii) Human Poverty Index for selected OECD Countries (HPI-2)

(iii) Gender - related Development Index (GDI)

(iv) Gender Empowered Measurement (GEM)

Gender - related Development Index (GDI), together with the Gender Empowerment Measure (GEM), was introduced in the year1995 whereas the Human Poverty Index (HPI) was introduced in the year 1997. There are two indices namely the HPI - 1, which measures poverty in developing countries, and the HPI-2, which measures poverty in OCED developed economies. From the above discussion it must be clear that India is assessed under HPI-1.

Out of these above mentioned five indices, HDI, HPI-1 and GDI are calculated by three common dimensions namely. a long and healthy life, knowledge and a decent standard of living. But some of the indicators are different within these dimensions. Let us know their similarities and differences from the table 23.1 given below.

Table 23.1: A comparative analysis of Dimensions used in HDI, HPI-1 and GDI

Sr. No.	Indices	HDI	HPI-1	GDI
1	A long and healthy life	● Life expectancy at birth	● Probability at birth of nots wimming to the age of 40	● Female and male life expectancy at birth

2	Knowledge	● Mean year of schooling ● Expected year of schooling	● Adult literacy rate	● Female and male mean years of schooling for adults ages 25 years and older ● Female and male expected years of schooling for children
3	A Decent Standard of Living	● GDP per capita (Adjusted do purchasing power parity in US dollar)	● The percentage of the population not using an improved water source ● The percentage of children under -weight for their age.	● Female and male estimated earned income.

Till now you might have understood the importance of human development and about indicators used by UNDP to measure HDI, GDI and HPI-1. Let us now have a closer look at India's position at international level as far as human development is concerned. We will also try to find out the reasons for low levels of human development in India.

INTEXT QUESTIONS 23.1

1. What is Human Development Index?
2. Differentiate between human development and economic development
3. Name the three dimensions and their respective indicator used for measuring HDI.

   (i)

   (ii)

   (iii)

23.3 INDIA: TRENDS OF HDI

According to Human Development Report 2021-2022 India's rank was 133 out of 191 countries of the world. All the 191 countries are grouped under four categories. These are

very high, high, medium and low. The countries which had value 0.800 and above are grouped under very high whereas the countries which had values ranges 0.700 to 0.799 were ranked as high human development. The countries which had value between 0.550 to 0.699 were ranked under medium categories and countries which had value less than 0.550 were ranked as low human development countries.

According to Human Development Report 2021-2022, India ranks 132 out of 191 countries of the world. India was placed almost at the bottom of the table in the medium level category. Our neighbouring countries like China (78), Sri Lanka (73), Maldives (90), and Bhutan (127) remained well above the India's position. Other neighbouring countries like Myanamar (149), Pakistan (161) and Nepal (143) were placed below India. If we compare at global level, the countries which lies below India were mostly from Africa and rest few countries were from Asia.

Analysis of all the four parameters provide us a better picture about the current status. Out of four, India has declined on three parameters and improved on one. Firstly, in health, life expectancy has fallen down from 69.7 to 67.2 years. As far as education is concerned out of two indicators, there is a drop in expected years of schooling, but mean years of schooling have seen an increase. This drop is because of the school closure during the Corona pandemic. Lastly, the standard of living; this is where the Gross National Income (GNI) per capita comes in and for India, it has fallen from $6,681 to $6,590.

If we look at India's situation over the time we can definitely say that it has improved a lot over the years. During the last 31 years (1990 - 2021), it has been observed that India has continuously improved its human development score till 2019. In fact, the decline started after 2019 (0.645). There has been a decline in the year 2021 in comparison to 2020 (Table 23.2). This was mainly due to Corona pandemic. This has not only happened with India but also with most of the developed countries those are already in the very high and high category.

Table 23.2: INDIA: Human Development Index Trends in India 1990 - 2021

Years	1990	1995	2000	2005	2010	2015	2020	2021
India	0.434	0.438	0.491	0.534	0.575	0.629	0.642	0.634

This improvement is not sufficient enough. There are many small countries of Asia and Africa like Fiji, Mongolia, Tunisia, etc. are well above India. India has to work very hard to be placed among the top countries in the medium human development category (0.550 - 0.699). If the present trend continues it needs minimum 30 years to enter the high human development category. And for this, a rigorous effort particularly in the social sector like education, health and economic sector particularly reduction of poverty are required.

The following are some of the reasons to keep India at the bottom of human development (a)

rapid increase in population (b) large number of adult illiterates and low gross enrolment ratio (c) high dropout rates (d) inadequate government expenditure on education and health, (e) large proportion of underweight children as well as under nourished people (f) very poor sanitation facilities and low access to essential lifesaving medicines.

Apart from HDI, the performance of India is also not very encouraging as far as Gender Development Index (GDI) and Human Poverty Index (HPI) are concerned. According to Human Development Report, 2021-2022, India's GDI stands at 0.849 which is significantly behind the world average. As mentioned in the table 23.1 GDI measures disparities in the HDI by gender.

INTEXT QUESTIONS 23.2

1. What is India's position in Human Development Index according to Human Development Report-2021-2022?
2. What was India's GDI stands as per Human Development Report, 2021-2022?

28.3 HUMAN DEVELOPMENT INDEX - A STATE LEVEL ANALYSIS

Till now we have studied concept, measurement and status human development all over the world including India. But there are variations within India. Certain states are performing well and certain states are still lagging behind. In accordance with UNDP Human Development Report an attempt was made to rank various states of India in to different categories. Global Data Centre of UNDP has analysed the data at sub-national level also. In the below given HDI values of all the twenty eight states are given for the year 1990 and 2021.

Table 23.3: India : Human Development Index of States,1990 and 2021

Sr. No.	States	1990	2021
1	Andhra Pradesh	0.427	0.630
2	Arunachal Pradesh	0.442	0.665
3	Assam	0.412	0.597
4	Bihar	0.379	0.571
5	Goa	0.557	0.605
6	Gujarat	0.474	0.638
7	Haryana	0.471	0.691

8	Himachal Pradesh	0.484	0.703
9	Jammu & Kashmir	0.498	0.699
10	Jharkhand	0.562	0.589
11	Karnataka	0.447	0.667
12	Kerala	0.550	0.752
13	MadhyaPradesh	0.407	0.596
14	Maharashtra	0.498	0.688
15	Manipur	0.499	0.678
16	Meghalaya	0.461	0.643
17	Mizoram	0.531	0.688
18	Nagaland	0.539	0.670
19	Odisha	0.402	0.597
20	Punjab	0.501	0.694
21	Rajasthan	0.406	0.638
22	Sikkim	0.546	0.702
23	TamilNadu	0.475	0.686
24	Telangana	0.624	0.647
25	Tripura	0.449	0.629
26	UttarPradesh	0.398	0.592
27	Uttarakhand	0.627	0.672
28	WestBengal	0.443	0.624
29	India	0.434	0.633

If we analyse the patterns given in the above Table, it can be observed that there has been significant improvements in all the states of India over the last thirty years (1990-2021). However, as mentioned above the progress is varied. The below given table categorized all the twenty eight states in to four categories as suggested by Human Development Report.

Table 23.4: Levels of Human Development Index among States of India, 2021

S. No.	Levels of HDI	Range	Name of the State
1	Very High	Above 0.800	Nil
2	High	0.700 - 0.799	Kerala, Himachal Pradesh and Sikkim
3	Medium	0.550 - 0.699	Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhatisgarh, Goa, Gujarat, Haryana, Jammu & Kashmir, Karnataka, Madhya Pradesh, Maharashtra, Manipur, Meghalaya. Mizoram, Nagaland, Odisha, Punjab, Rajasthan, Telengana, Tamil Nadu, Tripura, Uttar Pradesh, Uttarakhand, West Bengal
4	Low	Less than 0.550	Nil

If you analyse the above mentioned table, you will find that not a single state of the country is in the very high category (0.800 and above). There are only three states namely Kerala, Himachal Pradesh and Sikkim are in the category of high human development. Rest of the twenty five states are in the medium category of human development.On the other hand, not a single state is there in the category of low human development(Less than 0.550). This has been due to constant efforts by the Government of India and State governments. If we compare the situation in relation to national average there are ten states which are below the national average. Identify these states from the above given tables. Try to find out the reasons responsible for this situation.

INTEXT QUESTIONS 23.3

1. Name any five states of India which are below national average in HDI.

2. Name the three states of India which are in the high category of HDI..

WHAT YOU HAVE LEARNT

The concept of Human Development Index (HDI) was propounded by Prof. Mehbub Al Haque. From 1990 onwards Human Development Report is published by UNDP annually

which reflects the status of human development in almost all the countries across the world. HDI is a composite index that measures the average achievements in a country in three basic dimensions of human development. They are long and healthy life, knowledge and decent standards of living. The basic difference between economic development and human development is that economic development entirely focuses on the increase of income where as the human development stresses in expanding and widening of all aspects of human life. In HDI, economic condition is one of the essential elements. Apart from HDI, various types of indices are constructed and published by UNDP. Some of the important indices are Human Poverty Index, Gender Development Index, Gender Empowered Measurement index, etc.

According to Human Development Report- 2021, India's rank is 132 almost at the bottom of the table in the medium level category. The reasons which keep India at the bottom of human development are rapid increase in population, large number of adult illiterates, low Gross Enrollment Ratio, inadequate government expenditure on education and health, large proportion of under-weight children as well as undernourished people, very poor sanitation facilities and low access to essential life saving medicines etc. Therefore, there is an urgent need to improve in health situation, educational attainment and increased standard of living and reduction of poverty level.

TERMINAL QUESTIONS

1. Differentiate among Human Development Index, Human Poverty Index and Gender Development Index.
2. Explain any four reasons in favour of the human development.
3. Write any four factors responsible for keeping India almost at the bottom of human development index table.

ANSWERS TO INTEXT QUESTIONS

23.1

1. The Human Development Index is a composite index that measures the average achievements of a country in three basic dimensions of human development such as long and healthy life, knowledge and decent standard of living.
2. Economic development entirely focuses on the increase of income. The human development stresses in expanding and widening of all aspects of human life.

Notes

3. (i) Long and healthy life measured by life expectancy at birth.

   (ii) Knowledge is measured by the adult literacy rate and the combined primary, secondary and tertiary gross enrolment ratio.

   (iii) A decent standard of living is measured by DGP per capita purchasing power parity in US Dollar.

23.2

1. 132 out of 191 countries.
2. 0.849

23.3

1. (i) Haryana, (ii) Himachal Pradesh, (iii) Karnataka (iv) Kerala, any other (Any three)
2. (i) Bihar (ii) Madhya Pradesh (iii) Uttar Pradesh (iv) Rajasthan, any other (Any three)

MODULE -10

Contemporary Issues and Challenges

24. Sustainable Development Goals (SDGs)

25. Environment, Health and Sanitation

24

SUSTAINABLE DEVELOPMENT GOALS

In the previous lesson, you got acquainted with the concept of human development, its regional pattern and need for its improvement. As you know the concept of development, largely focused on the betterment or advancement of human society but the pattern of development is characterised by inequality. For example, all the countries of the world want high income, social equality and a livable environment. But unfortunately, the level of development is inversely related to environmental development. Therefore, in this lesson, you will learn the concept and significance of Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs), Targets of SDG and its status with special reference to India.

OUTCOMES

After studying this lesson, learners:

- differentiates between MDGs and SDGs;
- describes the key concepts and significance of SDGs;
- explains sustainable development goals and their specific targets and
- elucidates the impact of SDGs on spatial development in Indian context.

24.1 CONCEPT OF DEVELOPMENT GOALS

As you know, Development is a multi-dimensional phenomenon which is a result of man-environment interactions. The goals of development revolve around the advancement of economic, social and environmental aspects. It has a different meaning for different people depending upon their requirements. For example, some people want a high income whereas others want a clean environment.

Notes

Natural Resources provides a base for economic development of a nation. A country with rich physical and human resources including radical technological skills are considered developed and vice versa. Initially, man conceptualised the meaning of development with high economic growth but which resulted in social inequality and a degraded environment. There is an inverse relationship between development and environment. Higher the level of development, the poorer the quality of the environment. Environmental degradation is the biggest threat to human survival and biota.

As discussed in the previous lesson, man is transforming its environment,to achieve the goal of economic development. The main aspect of economic development is per capita income or GDP. To achieve higher and higher economic growth, man has been using his physical and mental abilities with technological advancement and exploiting its environmental strengths.

Before World War II, economic development was the only motive of developmental activities, after that our aim of development shifted towards social and human development. In lesson 23, the concept of human development has been discussed. Human development is defined as a process of enlarging people's choices, namely enjoying a healthy life, acquiring knowledge, achieving a decent standard of living, and providing a long-run view of human well-being. Every day, humans are affecting the environment and its quality in a number of ways. For example, in Delhi, daily millions of tons of garbage are being produced, chemical rich unhealthy water is being discharged into the river Yamuna and air is also becoming unhealthy day-by-day due to rising vehicular pollution. Delhi, being the most developed city of India, is becoming unsustainable. Delhi is just an example; all the cities of the world are facing the same environmental problems. To save the planet,in 1963, Rachel Carson triggered an environmental movement in the United States of America.

Table 24.1: Development in the Modern Era

Age	**Discovery and Invention**	**Development Goals**
Mercantilism Era	Industrial Revolution	Economic Development
World War I and II	Socio-economic Inequality widens	
After World War II	Formation of United Nations	Social (Human) Development
Brundtland Commission	Sustainable Development	Environment Development
MDGs	United Nations framed Eight Development Goals	Economic and social Development

Notes

SDG's	United Nations incorporated nine more Development Goals in MDGs	Economic, social and environmental development

Background of Global Development Goals

You must have heard a famous saying that "Rome was not built in a day" similarly the setting up of developments goals was also not a day's job. It was initiated with an International Conference on the Human Environment which was held 50 years ago in Stockholm in June 1972. This was the first conference when representatives of developed and developing nations talked about environmental issues and define the right of human beings to a healthy and productive environment. In this conference, United Nations Environmental Programme (UNEP) was adopted. It was the beginning of an environmental movement in the world and environmental issues have become a part of discussion not only at environmental conferences but also in every international political meets. Its10th anniversary was celebrated in Nairobi in 1982, followed by the United Nations Earth Summit on Environment and Development held in Rio de Janeiro, Brazil in 1992. Sustainable Development was a key focus at the United Nations Conferences; however, the word Sustainable Development was introduced by the Brundtland Report, published by the World Commission on Environment and Development (WCED) in 1987.InOur Common Future, sustainable development has been defined as "compromising the ability of future generations to meet their own need". It Focuses on developing a world where environmental changes are in accordance with sound ecological principles and improving the well-being of everyone.

Commission Definition- It contains two important things for the present and future generations; one needs the poor and other restrictions forced by the state on the environment's carrying capacity.

In 1992, during the Earth Summit,a document was prepared on the future environment of the 21st century in which the linkages among economy, social development and environmental protection were recognized. The Rio Declaration, Agenda 21 and Commission on Sustainable Development were the key products of the Earth Summit and its aim was to achieve global sustainable development by 2000. It is a non-binding instruction plan for governments of the world with the main focus on poverty, population policy, health education, women's, young, underdeveloped countries, food security, pure water, security of water bodies, security from toxic chemicals and hazardous radio actives, proper land use and biodiversity, etc. It was felt that it requires a change in our attitude towards the environment and all human beings. If we are further destroying nature it means destroying ourselves. We have to realise that everybody deserves acceptable living standards but not on the cost of the environment.

Notes

Salient features of sustainable development are as follows:

- The rise in per capita income and economic development should be sustained with time.
- The use of natural resources should not be stopped but it should be used in a manner that they are not overexploited.
- There is no reduction in the ability of future generations to meet their needs.
- Sustainable development also discards those activities which increase pollution.
- Dealing with ill effects of climate change, how we can manage gender equality and better health.

In 1997, a Special General Assembly was held in New York which adopted a program for further implementation of Agenda21. Through international consensus, for achieving sustainable development the UN General Assembly accepted MDGs in 2000 for eradicating poverty, preventing deadly diseases, empowering women and ensuring environmental sustainability etc. to be reached by 2015.

After the 1992 Earth Summit, The World Summit on Sustainable Development (WSSD) which was held in Johannesburg, South Africa in the year 2002 evaluated the results and obstacles in the progress. This is also known as Rio+10. It was also addressing the global environment, poverty challenges, Agenda 21, MDGs and new issues like half the global population are without access to basic sanitation. The Earth Summit WSSD (2002) adopted an implementation plan which comprises a set of concrete steps and actions to be taken in order to fulfil targets and goals of development with a more focused approach.

The running SDGs were developed after the UN conference in Rio de Janeiro in June 2012 on Sustainable Development with the 2030 agenda for sustainable development. This is also known as RIO +20. In other words, SDGs are derived from the MDGs with adding new goals for fulfilling the needs of the increasing population and at the same time for protecting depleting resources and their quality, and also fulfilling the responsibility towards the needs of our future generations and prosperity of planet earth.

Table 24.2: Development Initiatives

Conference	**Year**	**Initiatives**
UNCHE	1972	Beginning of environmental movement in the world
Our Common Future	1987	"Sustainable Development" word as introduced.
Rio (Agenda 21)	1992	Document was prepared on the future environment of the 21st century

MDGs	2000	Adopted 8 goals for improving the lives of the poorest people of the globe
Rio+10 (WSSD)	2002	Adopted an implementation plan of actions in order to fulfil goals of development with a more focused approach.
RIO+20 (Sustainable Development)	2012	Universally applicable 17 goals were developed by UN for wellbeing for everyone

INTEXT QUESTIONS 24.1

1. When economic development was the main motive of development?
2. Which kind of development, the Brundtland commission report, was based on?
3. Who was Gro Harlem Brundtland?
4. What are the main approaches of Sustainable development?

24.2 MILLENNIUM DEVELOPMENT GOALS

The Millennium Declaration was signed by a gathering of global leaders of 189 nations at the United Nations Millennium Summit in September 2000 with the aim to achieve a better world and better tomorrow. The Millennium Development Goals (MDGs) were derived from this historic declaration. In MDGs, there were a total of 8 goals for improving the lives of the poorest people of the globe. Several measurable targets and indicators were also set for each goal. The targets to meet these goals were set to be achieved by 2015 and monitor the progress from the levels of 1990. Through these goals, the international community tried to expand its vision to combat poverty and pro-poor growth. The 8 measurable goals from poverty to gender equality, improving mortality among children and women and ensuring environmental sustainability targets were as follows.

Table 24.3. Millennium Development Goals and Targets

MDGs	**Targets**
1. Eradicate extreme poverty and hunger	• Reduce by half the proportion of people living on less than a dollar a day • Reduce by half the proportion of people who suffer from hunger

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2. Achieve universal primary education	● Ensure that all boys and girls complete a full course of primary schooling
3. Promote gender equality and empower women	● Eliminate gender disparity in primary and secondary education preferably by 2005, and at all levels by 2015
4. Reduce child mortality	● Reduce by two thirds the mortality rate among children under five
5. Improve maternal health	● Reduce by three quarters the maternal mortality ratio
6. Combat HIV/AIDS, malaria other diseases	● Halt and begin to reverse the spread of HIV/AIDS ● Halt and begin to reverse the incidence of malaria and other major diseases
8. Develop a global partnership for development	● In cooperation with the private sector, make available the benefits of new technologies-Especially information and communications technologies.

In the time span of fifteen years, the MDGs drove progress in some important areas like reducing income poverty, providing much-needed areas to water and sanitation, driving dawn mortality and drastically improving maternal health. It also kick-started a global movement for free primary education, inspiring countries to invest in their future generations. Most significantly, the MDGs made huge strides in combating HIV/AIDS and other erectable diseases such as malaria and tuberculosis.

Main Achievements of MDGs

- Under Goal 1, extreme poverty was reduced significantly from the level of 1990 when 50 percent of people lived on less than $ 1.25 day and that declined to 14 percent in 2015. More than 1 billion people have been lifted out of extreme poverty since 1990.
- Improvement in primary education and in enrolment has increased in developing regions. Especially sub - Saharan Africa is the best example of the improvement in primary education after the MDGs initiative. About 20 % increase was noticed from 2000 to 2015 in net enrolment. It has also fallen in the number of out-of-school children in primary school since 1990.
- Child mortality dropped by more than half between 1990 and 2015. The number of deaths of children under the age of five has declined from 12.7 million (1990) to 6 million (2015). Its annual rate of reduction in mortality was more than five times faster

during 2005-2013 in the sub- Saharan Africa region.

- About 45 % decline was recorded globally in maternal mortality since 2000. It declined 64% in southern Asia and 49% in sub-Saharan Africa.
- HIV/AIDS infections fell by almost 40 percent (since 2000).
- The services like access to improved drinking water piped drinking water have also improved worldwide. About 147 countries have met the target of drinking water, 95 countries met sanitation and 77 countries have met both targets. More than half of the global population is enjoying a higher level of services.
- Assistance from developed countries and duty-free import from developing countries has increased since 2000. About 95% world population is covered by a mobile signal and very huge growth in internet service to the world population only 6% in 2000 to 43% in 2015. Due to this 32 billion people are linked for content and applications through the global networks.

India has achieved targets of poverty reduction and hunger, gender parity in enrolment of primary, secondary and tertiary education, maternal mortality, and disease like tuberculosis is controlled, increased in forest cover etc. Apart from this, the situation has been improved in access to clean drinking water, controlling emission in greenhouse gases but still remain big challenges.

INTEXT QUESTIONS 24.2

1. When Millennium Development Goals were adopted?
2. What was the base year of measuring progress in MDGs?
3. What were the three most important areas where MDG succeeded?
4. In which goals of MDG, India has achieved the targets?

24.3 SUSTAINABLE DEVELOPMENT GOALS

The word Sustainable Development was used for the first time in World Conservation Strategy (WCS) in 1980 by the International Union for the Conservation of Natural Resources (IUCN). But the concept has been further explained by the World Commission on Environment in 1983. The World Commission on Environment on Development (WCED), Gro Harlem Brundtland was appointed as the chair of the commission and the report was known as Brundtland Commission Report. In the report, several concerns about the negative impact of human activities and developments on planet earth have been raised and also underline that if

they are not controlled, the future will be unsustainable.

The development with a sustainable approach is very much correlated with Economic growth, Social equality and Environment protection.

In addition to that, sustainable development has a deeper meaning. For instance, in a sustainable situation, people may have more employment opportunities; everyone can afford nutritious foods, quality education, social and gender equality and human rights. Overall, this is about improving everyone's social status and wellbeing. This is a people-centric initiative.

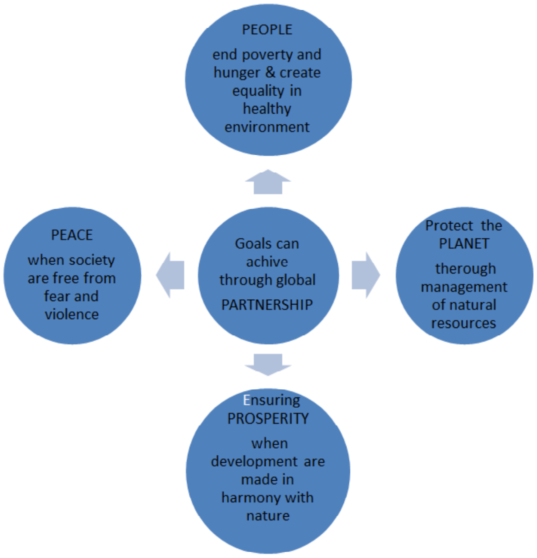

Fig 24.1: Five P's of Sustainable Development

The SDGs are a set of agreements on 17 universal goals adopted by world leaders of 193 countries in the 70th session of the UN general assembly held on 25th September 2015. The adopted document was entitled "Transforming our world: the 2030 Agenda for Sustainable Development". This 2030 agenda is for transforming towards sustainable development or the future we want. It came into operation in January 2016. It is also a succession of MDGs. SDGs accepted by UN member states; provide a blueprint for peace and prosperity for people and the planet earth. All the 4 P's are governed by partnership in sustainable development. The most important aim of this agreement is to end poverty and it covers multiple aspects of growth and development. It is an urgent step towards action by all developed and developing nations in a way of global partnership.

The SDG's are synthesis or integration of MDG's with some new objectives. The SDGs are unique in that they cover issues that affect all of us. They refer to our international commitment to end poverty. Table 2 shows all objectives with their focus targets for action to tackle rising poverty, empower females and addressing the climate emergent situation. Further, it is also recognized that ending poverty and hunger and other goals must go hand in hand with strong

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policy and strategies for inequality, economic growth, improvement of health and education, and dealing with climate change, preservation of land and oceans.

Table 24.4: Objectives of SDG's

SDG	**Objective**
No poverty	End of Poverty in all its forms
Zero hunger	End hunger, achieve food security and improved nutrition & to promote sustainable agriculture
Good health and well-being	Achieve gender equality and empower all women and girls
Quality education	Ensure inclusive and equitable quality education and promote lifelong learning Opportunities for all.
Gender equality	Achieve gender equality and empower all women and girls
Clean water and sanitation	Ensure availability and sustainable management of water and sanitation for all
Affordable and clean energy	Ensure access to affordable, reliable and sustainable modern energy for all
Decent work and economic growth	Promote inclusive and sustainable economic growth, full and productive employment and decent work for all.
Industry, innovation, and infrastructure	Build resilient infrastructure, promote inclusive and sustainable Industrialization and foster innovation
Reduce inequality	Reduce inequality within and among countries
Sustainable cities and communities	Make cities and human settlements inclusive, safe, resilient and sustainable
Responsible consumption and production	Ensure sustainable consumption and production pattern
Climate action	Take urgent action to fight climate change and its mpact
Life under water	Conserve and sustainably use the oceans, seas and marine resources for sustainable development
Life on land	Protect, Restore and promote sustainable use of

	terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
Peace, justice, and strong institutions	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
Partnership for the goals.	Strengthen the means of implementation and revitalize the global partnership for sustainable development

Pillars of Sustainable Development Goals

Above 17 goals, the focus is now building a sustainable world. The core of all SDGs can be classified in the form of 4 pillars such as human, social, economic and environmental. All goals move and deal around these pillars in others wards SDGs focus on building a sustainable world through these pillars of sustainability for the stability of human civilization and its environment.

- **Human Sustainability:** Human development is a core of SDGs and most of the goals are directly and indirectly related to this. To maintain human sustainability need to improve human capital. Therefore to end poverty and remove hunger need to invest in poverty eradication. Apart from this investment is also required in the health and education sector, access to services, nutrition, and knowledge and skill enhancement for improvement of health and completing economic wellbeing for all. for maintaining good health and wellbeing have to end preventable death of newborns and children of age below 5 years in all countries, ends the epidemics of Aids, tuberculosis, malaria, water-borne diseases and other communicable diseases etc. through development of skills and capacity building, we can promote the wellbeing of communities and society.

- **Social Sustainability:** this is an ability of a community to preserve and maintain social quality like culture, cohesion, and honesty, not for present need but the support of future generations and their wellbeing. For ensuring social sustainability aim to improve social capital by investing and creating services that constitute the framework of our society. To create a socially successful place and healthy and livable communities need to focus nation wise social protection system, ensure equal rights on resources particular poor's, gender equality, empowering the deprived group, social security and provide democratic good quality of life etc.

- **Economic Sustainability:** improvement of the standard of living is the main aim of economic sustainability. Without economic growth, we can't achieve sustainable

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development. Both quality and quantity of growth are important but will have without harming the ecology and human capital. It is about those practices which support future economic growth without harming our social-cultural and environmental aspects of the community.

- **Environmental Sustainability:** The most important and demanding pillar of sustainability. Aim to achieve environmental sustainability through the protection of our natural capital like air, water, land, and natural resources etc. without the environmental sustainability pillar; we can't achieve the aim of other pillars. For example, the supply of agricultural products can be expanded without damaging our natural resources by adopting sustainable farming methods that preserve agricultural productivity of land while minimising pollution of the soil, groundwater and streams that drown the land.

INTEXT QUESTIONS 24.3

1. In which session sustainable development goals were adopted?
2. What are the important P's in sustainable development?
3. Which Government body is coordinating SDG in India?

24.4 SIGNIFICANCE AND DIFFERENCE BETWEEN MDGS AND SDGS

SDGs can be called as an expanded form of MDGs for carrying forward the unfinished agenda of MDGs and also continuity for addressing the additional environmental, political and economic challenges which are faced by our present generation. The aim of the goals is to encourage development by improving social, economic and environmental conditions in the world's poorest and under-developed countries such as sub-Saharan countries, Latin American countries etc. They are categorised as long-term goals having a duration of 15 years. MDGs were completed in 2015 whereas the target to achieve SDGs will be 2030.

Table 24.5: Difference between MDGs and SDGS

Criteria	MDGs	SDG'S
Aim	To boost development	To achieve both sustainability and development
Origin	MDGs were drawn with a group of experts from UN headquarters.	SDGs have evolved after a long and extensive consultation including 70 open working groups, Civil Society Organization, thematic consultation, country consultations, participation of the general public through face

		to face meeting and online mechanism and door to door survey.
No. of Development Goals	The MDGs were focused with only 8 goals, 21 targets and 63 indicators.	Includes 17 with 169 targets, it's have wider coverage
Funding	In the case of SDGs all countries are within its focus and funds are made available via various global agencies and countries.	As MDGs had focused on developing countries while they assumed that funding would come from via and from rich countries which did not materialise.
Period-Targets of Achievement	MDGs were adopted in 2000 and baseline year was 1990 and completed in 2015.	The SDGs has put more emphasis on real time data and baseline was estimated from 2015 to notice the progress towards these goals according to age, gender, education, health, migratory status and the whole population. 15 Years SDG's would have been accomplished by 2030.
Time Frame	2000-2015	2015-2030
Nature of Goals	At the time of MDGs gender, people participation and local governance were not considered as important while poverty	Goals are more accommodative and comprehensive with an emphasis on gender and environmental dignity. It's also evident that SDGs take into account the nuanced aspect of our social living conditions.
Stakeholders	It was noticed that LDC were in the focus as they were urged to take actions and had no role for the civil society organisation or local bodies.	In SDGs all nations are supposed to act and respond towards the crisis and demand that local self-governance be made functional
Role of private sector	MDGs were more rooted in interg overnmental	SDGs are more clear and welcoming about the role of private players in the development process. It includes a vision of building a

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	cooperation and actions.	vibrant and systematic partnership with the private sector to achieve sustainable developments.

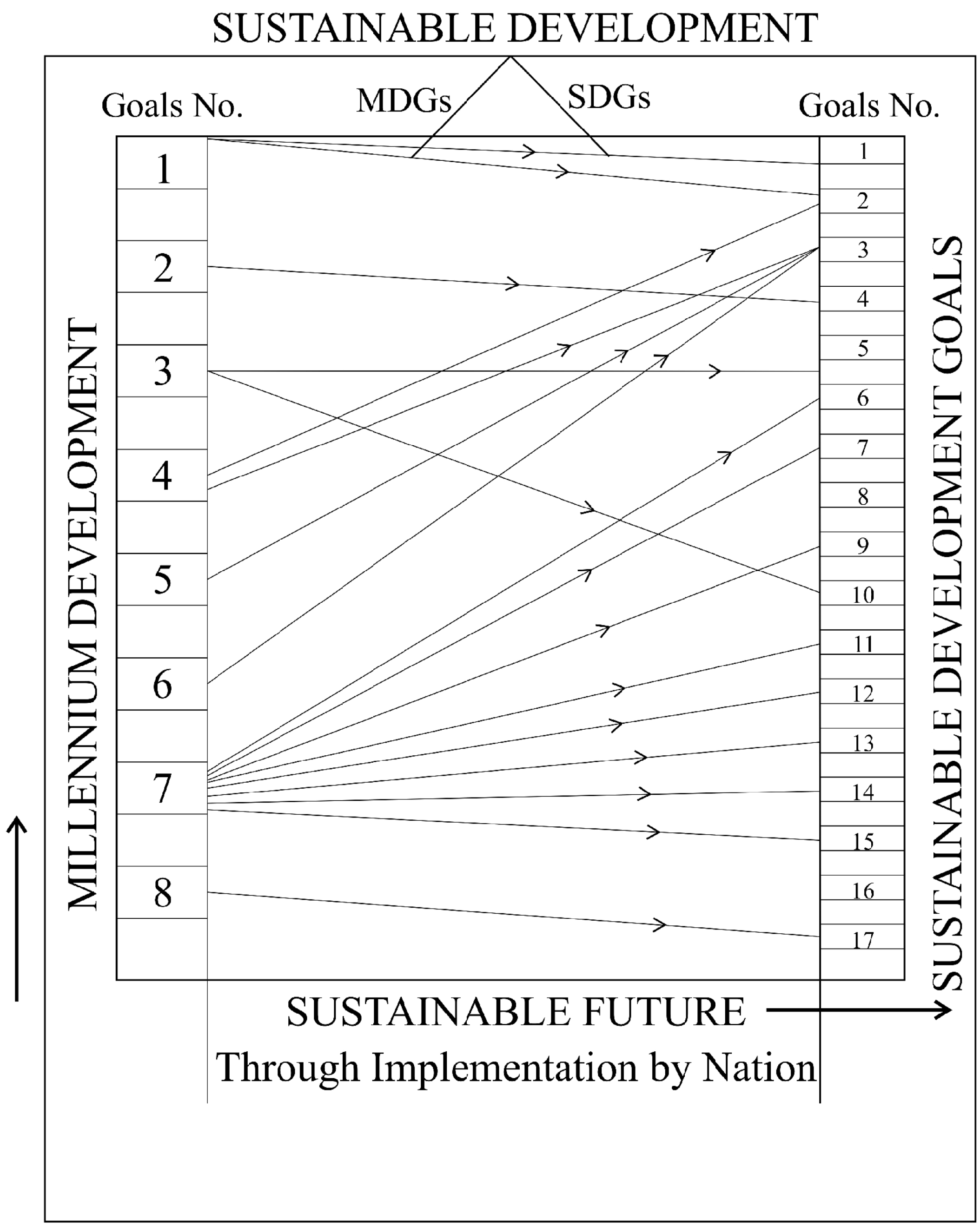

Fig 24.2 : Sustainable-Future through Implementation by Nation

Both categories of goals are known and applicable as global goals, accompanied by goal wise targets and elaborated through indicators of measurable outcomes which are action oriented (Figure 3).

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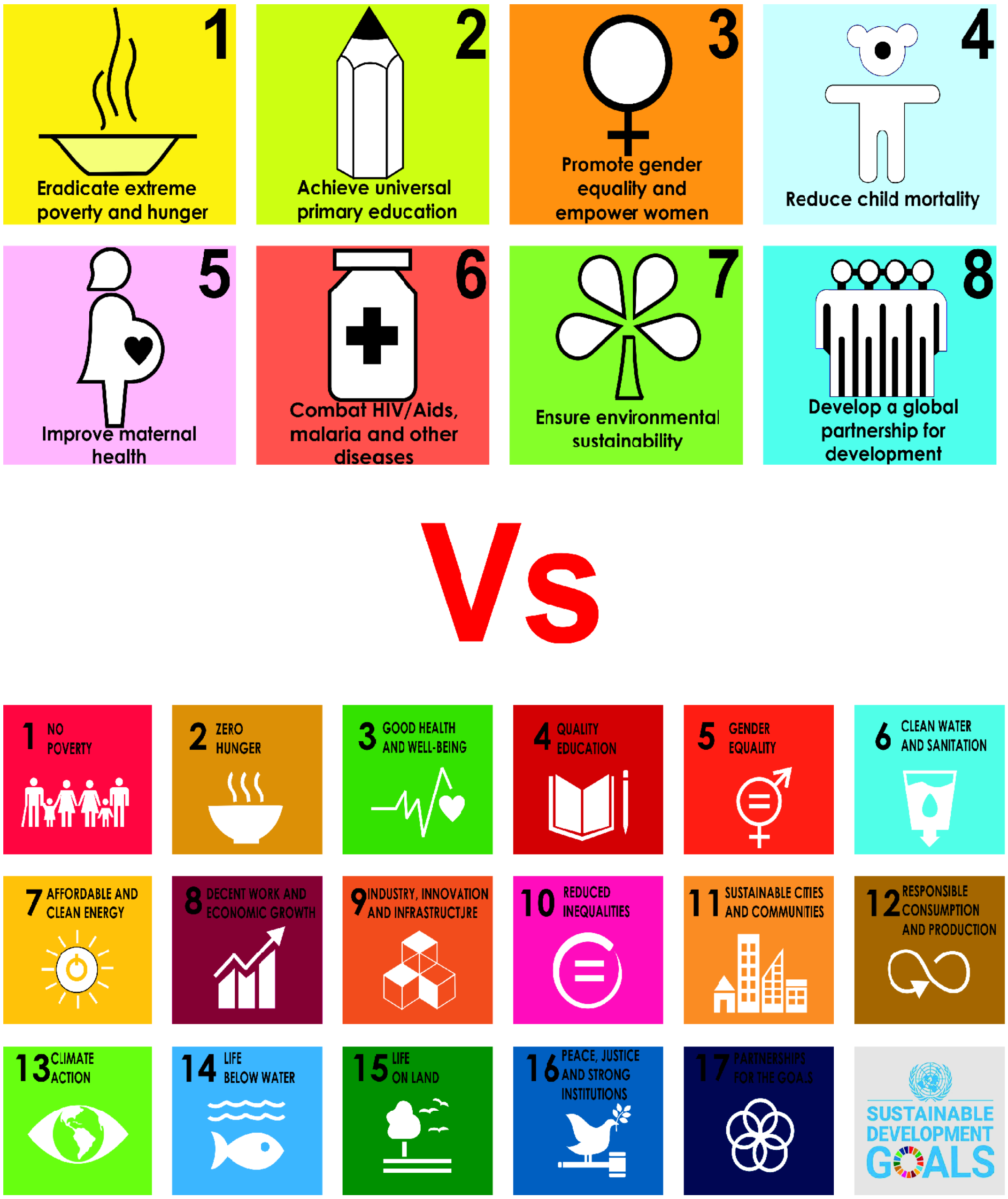

Fig 24.3 : MDGs and SDGs

Constraints With SDGs

The single and most important failure is that achievements of goals were not experienced across the globe. Some regions like southeastern Asia, southern Asia and northern Asia exceeded the goal in poverty reduction by 16%, 12.5%and 1.2% respectively. Sub - Saharan region was most behind in meeting the goals of MDGs.

Sustainable development remains only an environmental issue and it has been competing for only agendas. Global biodiversity of all species is declining, developed countries have not met a commitment to developing countries, many of critical ecosystem services like water,

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biodiversity, fibre and food is being compromised due to the impact of human development, many countries in the world facing freshwater scarcity, income inequality has also been observed in past 2 decades in many countries and gap between rich and poor is growing etc. indicates the failures of sustainable development agendas.

24.5 INDIA'S PERSPECTIVE AND STATUS IN SDG

Global Sustainable Development 17 goals with 169 targets are a core part of India's national development agenda. India is also giving priorities to achieve high economic growth, streamlining sustainable development and human well-being. Our development focuses on poverty, health, nutrition, sustainable growth, gender equality, quality education and clean water and environment like others several issues to human survival. NITI (National Institution for Transforming India) Aayog is the premier body of the Government of India has been coordinating Sustainable Development Goals with the supported ministry of each target. A comprehensive mapping of SDGs goals and targets with various schemes and programs has been developed so that it brings together economic, social and environmental pillars with a focus on their inter-linkages. On the basis of global agreed goals and targets, NITI Ayog selected priorities indicators by several consultations with all stakeholders and involving Central ministries, States/UTs, civil society organisations, academia, business sector and to compute India's SDG index.

The State and local governments have a key role in India's progress on SDGs agenda and implementation of numerous programmes like National Health Mission, Swach Bharat Abhiyan, SarvaShikshaAbhiyan, National Programme of Mid-Day Meal in school, National Rural Drinking Water Programme, Pradhan Mantri Awash Yojana, Sabka Saath Sabka Vikas, National Urban Livelihood Mission, National Rural Livelihood Mission, National Food Security Mission and Digital India etc. So that no one is left behind. The State / UTs has been divided into 4 categories as per the SDG India index are Aspirant (0-49), Performer (50-64) , Front Runner (65-99) and Achiever (100).

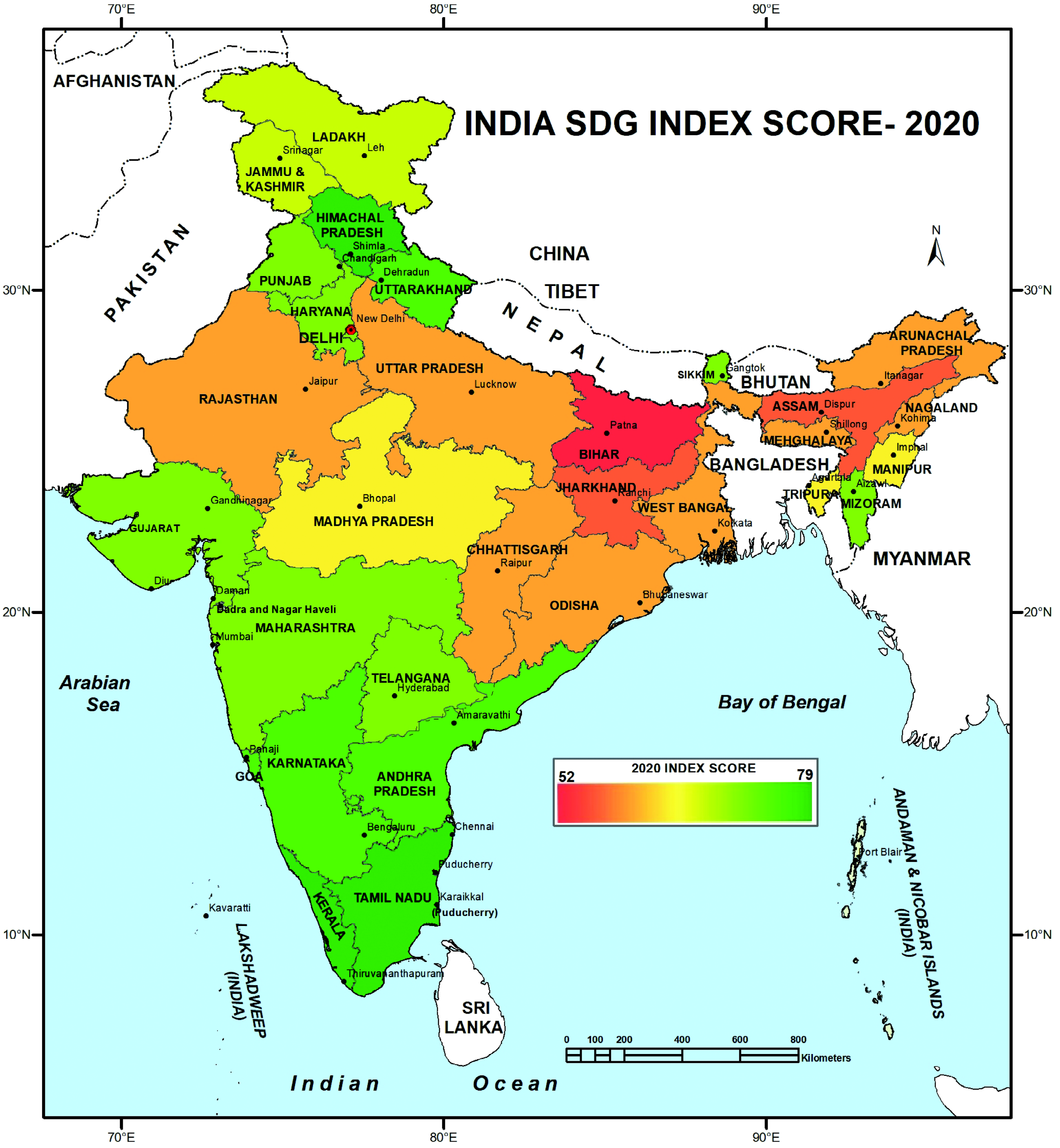

Fig 24.4 : India : SDG Index Score - 2020

About one-third of the journey towards SDGs agenda has already been achieved. In the areas like health, energy and infrastructure, goals of SDGs have shown substantial progress in the country. The overall score of the SDGs index has grown up and progressed largely due to improvement in clean water and sanitation and affordable and clean energy in the country. As

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per the report of NITI Aayogwhich highlighted the role and significance of partnership among states/UTs.It has been found that15 states/UTs are in the performer category and 22 states/ UTs in the front runner category. The areas like the abolition of poverty and hunger have shown improvement in the index whereas campaigns to improve the access of households to electricity and clean cooking fuel have been important factors of improvement. On other side, the area which showed a decline in the SDG India index is Industry, Innovation and Infrastructure due to the lockdowns enforced by the governments.

The overall state wise analysis depicts that, Kerala has achieved the highest score (75) in the index due to its improvement for the effort to tackle hunger (goal 2) and to provide quality of education of students (goal 4), followed by Himachal Pradesh, and Tamil Nadu with a score 74 (Figure 2). Chandigarh has achieved the top score (79) among UTs followed by Delhi (68). In terms of regional analysis, there has also been a significant difference in the performance between the southwestern and north-central states which indicates socio-economics and governance gaps.

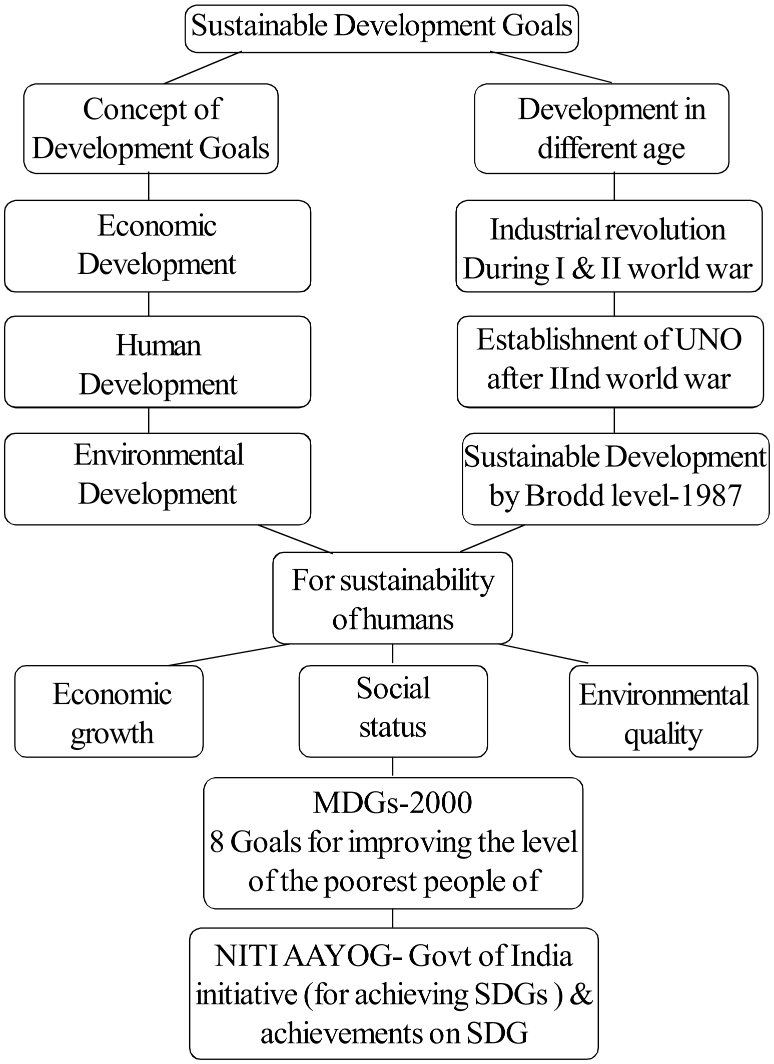
Lack of finance, population growth, recent Covid pandemic, and behaviour towards resource consumption are the challenges in achieving sustainable development in India. For example, India has only 5 percent of the required funding for the implementation of SDG goals, which is very insignificant for the essential sectors like health (1.5%) and education (4%) which is far below the required level. Indian states need to improve their performance on concerns like inequality, reducing poverty; hunger, improving the environment etc. to achieve targets.

All SDGs goals are inter-connected, if we succeed in one affects the success of others goals. The SDGs are well-framed plans to achieve global challenges which we are facing including poverty, inequality, health issues, sanitation, gender issues, climate change, environmental degradation, inequality, poverty, peace and justice etc. to move the world to a more sustainable place. The SDGs are exceptional in that way as they cover issues that affect us all. In short, this is the initiative to improve life for further generations.

INTEXT QUESTIONS 24.4

1. What was the time duration to complete MDGs?
2. What is the main aim of SDG?
3. How many goals and targets are in SDG?
4. By what time the targets of SDG will be completed?
5. Which states/UTs score highest in India's SDG index?

WHAT YOU HAVE LEARNT



TERMINAL QUESTIONS

1. Write a short note on millennium development goals.
2. What are the major achievements of MDGs?
3. Describe Sustainable development goals with its targets in brief.

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4. What is NITI Aayog and what is its role in SDG.

5. Explain pillars of sustainable development.

6. Describe progress of Sustainable development goals in India's.

7. Distinguish between the MDGs and SDGs.

ACTIVITY:

Make a list of reasons for the gap of development among developed and developing countries.

ANSWERS TO INTEXT QUESTIONS

24.1

(1) Before World War II.

(2) Sustainable Development.

(3) Gro Harlem Brundtland was the chair of the world commission on the environment and development.

(4) Economic growth, social equality and environment protection.

24.2

(1) In September 2000.

(2) 1990

(3) Extreme poverty, Primary education and Child mortality.

(4) Poverty reduction, Enrolment in primary education and maternal health.

24.3

(1) 70th session of the United Nations.

(2) People, Planet, Peace, Prosperity and Partnership.

(3) NITI Aayog.

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24.4

(1) 2000-2015.

(2) To achieve both Sustainability and development.

(3) 17 goals and 169 targets

(4) By 2030.

(5) kerala.

25

ENVIRONMENT, HEALTH AND SANITATION

In the previous lesson, you have learnt about the concept, significance and global pattern of human development and Sustainable Development Goals (SDGs). As you know, there is a close relation between the environment and human development. For example, we have constructed dams for electricity generation, irrigation and to fulfil other purposes but it leads to deforestation and loss of biodiversity. Similarly, industrialization and urbanisation accelerated various types of pollution along with loss of fertile agricultural land which eventually created ecological imbalance on our planet. However, the quality of air, water and landis deteriorating day by day which is impacting human health. In this lesson, you will learn the link between environment, sanitation and health along with the issues, challenges, health risks possessed by them, government initiatives and different types of traditional medicines and health practices. Therefore, in order to understand health, it is very important to get familiar with our environment.

OUTCOMES

After studying this lesson, learner:

- identifies the linkages between the environment, health and sanitation;
- describes environmental management to minimise the health risks;
- explains the overview of government initiatives like Namami Gange, Ujjwala Scheme and Swachh Bharat Abhiyan, and
- elaborates the traditional medicines and health practices for common health issues.

25.1 CONCEPT OF ENVIRONMENT, HEALTH AND SANITATION

The terms environment, health and sanitation seem very simple but they are very complicated to understand as all of them are interrelated to each other. There is a direct relation between environment, health and sanitation. In other words, Sanitation stimulates health and improves

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the quality of environment.For instance, according to SwachhSarvakshen 2021, Indore is the cleanest city of India which signifies that it maintains hygiene and sanitation and residents of the city fall comparatively less sick and enjoy good health.Now let's understand all the terms in details.

A. Environment

Environment simply means our surroundings. The conditions in which we live, recreate and work is called the environment. There are two types of environment namely physical and human. The physical environment includes air, water, sunlight, land and its attributes like plants, animals etc. On the other hand, the human environment consists of man-made features created and modified by humans such as buildings, dams, roads etc.

Components of Environment

Environment is a composite form of biotic and non-living or abiotic organism within which human beings live and work. It includes natural as well as social, cultural and economic environments. Thus, the environment contains a complex relationship between various living organisms and many external forces which affects lives of organism.Human being totally depends on the environment as it provides all types of resources that are required for their survival.

Factors of the environment have been divided into following components. All of them are closely related, directly or indirectly, to a healthy man and his environment.

- **Physical -** climate, air, water land use land cover, altitude
- **Biological -** Bacteria, viruses, insects, rodents, animals, population size, sex-age structure.
- **Economic-** Occupation, , average wages, inequality, poverty, sectoral makeup of urban economy
- **Social -** Customs, culture, habits, availability of medical establishment and relative size of medical personnel.

B. Health

As you all must have heard a proverb since your childhood that "health is real wealth". When we say we are healthy, it means "Health is something special.

Health is very dynamic by nature and varies from person to person and from region to region. It is an equilibrium between man and his environment. Health is a level of functional condition of a person's mind and body. Generally, health means to be free from illness, injury or pain. Well known definition given by the World Health Organization (WHO) in 1948 has defined health as "a state of complete physical, mental and social well-

being and not merely the absence of diseases or infirmity". Do you know about World Health day? And when it is celebrated? It is celebrated on 7th April which is World Health Day.

As per WHO three specific dimensions of health are:

1. **The physical -** perfect functioning of the body

2. **The mental -** a state of balance between the individual and the surrounding world.

3. **The social -** quantity and quality of an individual's interpersonal ties and the extent of involvement with the community.

In simple words, health is the absence of illness or disease and the presence of mental, social and physical wellbeing. As per ancient view health implies sound mind, in a sound body in a sound family in a sound environment.

Many health related issues and diseases have their origin in the above environment. Diseases have source area (core), spread (diffuses) through humans along identifiable rates and affect clusters of population (region).

Improving the quality of the environment in key areas such as air, water and noise can prevent many diseases and improve human health.

Health is a complex system of interaction among the environment, human population and cultural behaviour. Sound health is essential to lead a "socially and economically productive life". It is also associated with many other things.

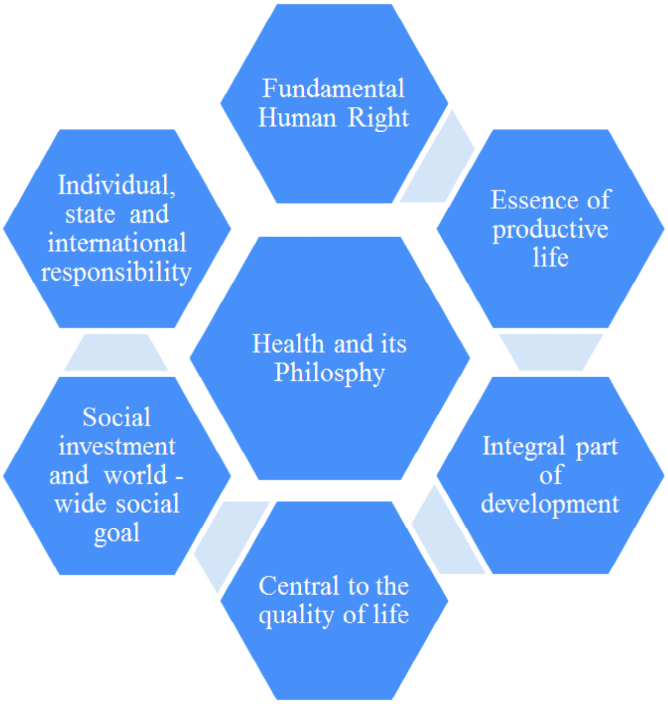


Fig: 25.1 Philosophy of health

From an ecological point of view, diseases are defined as "maladjustment of the human organism to the environment".

Human health is a combination of many factors like nutritional, biological, chemical and psychological. In all factors, the environment has a direct impact and consequences on human health. The types and frequency of various diseases very much depend on environmental conditions. Diseases can be classified in two broad categories: Infectious (communicable) diseases and Life-Style (chronic non- communicable) diseases.

Disease is a product of interaction among the agent,host and environment. The agent and the host mutually interact and both can currently interact with the complex matrix called the environment which is both physical and cultural. The triangle is showing the interaction and interdependence of agent. Example is communicable disease. In this, agent is the cause of disease; the host is an organism, commonly a human or an animal that cause or allow disease transmission: and time account for incubation period, life expectancy of the host or the pathogen and duration of the course of illness of condition.

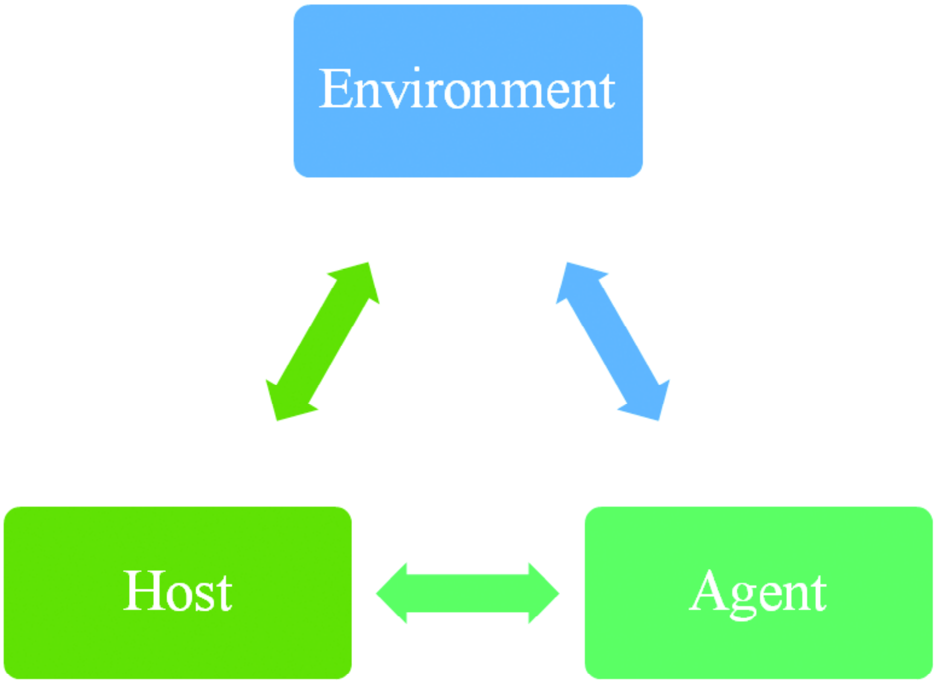


FIG: 25.2 Trilogy of Disease

Health is an inseparable part of the developmental process. Man's poor health can be traced to environmental factors such as pollution, housing conditions, presence of animal and insect vectors or disease which pose a constant threat to man's health. Therefore we can say, Health is linked with environmental conditions.

Health is a real wealth, in order to maintain good health it is the first priority of any human being.Environmental determinants such as air pollution, climate change, contamination with hazardous chemicals, uncontrolled waste generation and disposal. Public health issues like morbidity and mortality both have increased due to increase in pollution level.

Health is determined by following factors such as :

a. Exposure to outer environment

b. Climatic conditions

c. Sanitation condition

d. Living condition

e. Land use/cover

f. Eating habits/ food habits

g. Occupation

h. Daily routine/ life style

To maintain good health, we need to address adequate sanitation, together with safe water. It is a fundamental need for good health and for social and economic development.

C. Sanitation

Sanitation means the prevention of human contact with waste for hygiene purposes. It also means promoting health through the prevention of human contact with the hazards associated with the lack of healthy food, clean water and healthy housing and clean environment.

As per the dictionary meaning of the word Sanitation is the "the science of safe- guarding health".

According to the National Sanitation Foundation of the USA "Sanitation is a way of life."

The term "Environmental Sanitation" has been defined by WHO as "the control of all those factors in man's physical environment which exercise or may exercise a deleterious effect on his physical development, health and survival "

Sanitation covers almost controlling the environment with a view to prevent diseases and promote health. It's about quality of living that is expressed in the clean home, clean family, clean neighbourhood and the clean community. Currently, environmental sanitation is the most important health issue. Environmental health is broader than hygiene. It encompasses hygiene, sanitation and many other aspects of the environment. Hygiene generally refers to the set of

practices associated with the preservation of health like personal hygiene, household cleanliness, and community cleanliness. The focus is mainly on personal hygiene, diet looks at cleanliness of hair, body, clothing and menstrual hygiene. Environmental health addresses all the physical, chemical and biological factors that are connected to disease transmission.

It focuses on management of wastes produced by human activities. We can break the vicious cycle of diseases by achieving environmental sanitation. Generally, principles of sanitation apply to both urban and rural problems.

There are different types of sanitation relating to particular situation such as given in figure

- Basic sanitation refers to the management of human faeces at the household level. It means access to a toilet; onsite sanitation; the collection and treatment of waste at the place where it is deposited.
- Food sanitation refers to the hygienic measures for ensuring food supply.
- Environmental Sanitation is about the control of environmental factors that form links in disease transmission. It includes solid waste management, water and wastewater treatment, industrial waste treatment, noise and pollution control.
- Ecological sanitation based on the concept of recycling the nutrients from human and animal wastes to the environment.

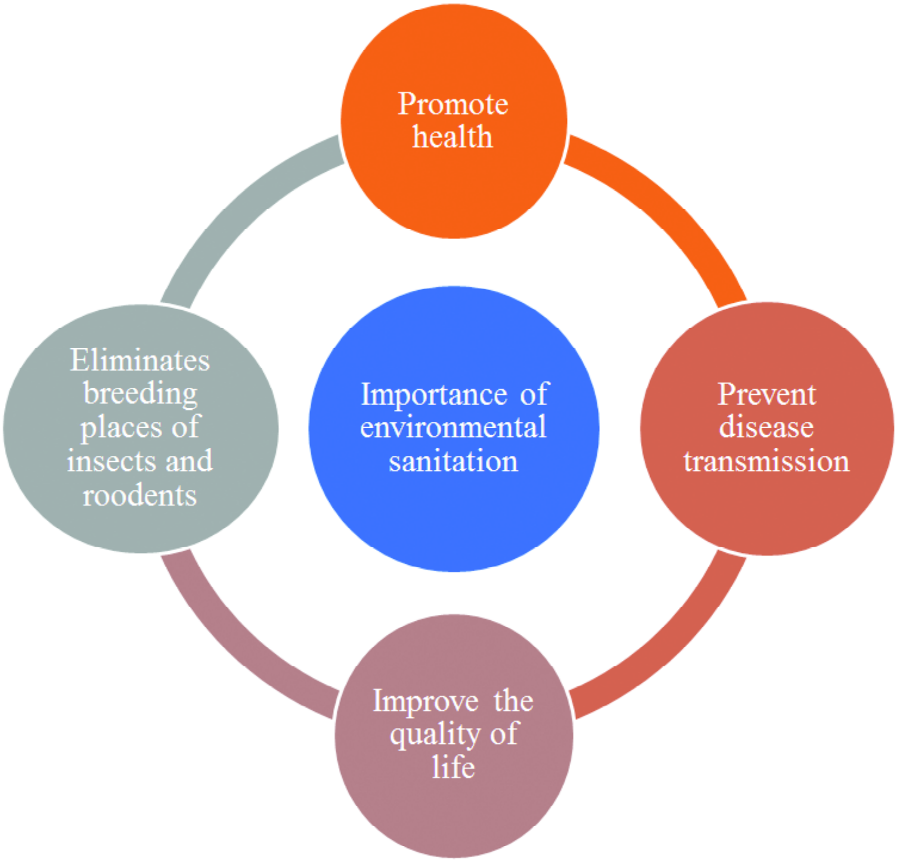


Fig. 25.3: Sanitation and its importance

Sanitation refers to public health conditions like clean drinking water and adequate treatment and disposal of human excreta and sewage. The aim of sanitation systems is to protect human health by providing a clean environment that will stop the transmission of disease, especially through the faecal - oral route. For example diarrhoea, a main cause of malnutrition and stunted growth in children can be reduced through sanitation. Therefore, adequate sanitation means good hygiene and safe water. This is also fundamental to good health and to social and economic development. By improving sanitation, we can improve quality of life and can prevent various diseases. That is the way by which the mortality rate will be reduced particularly in developing countries.

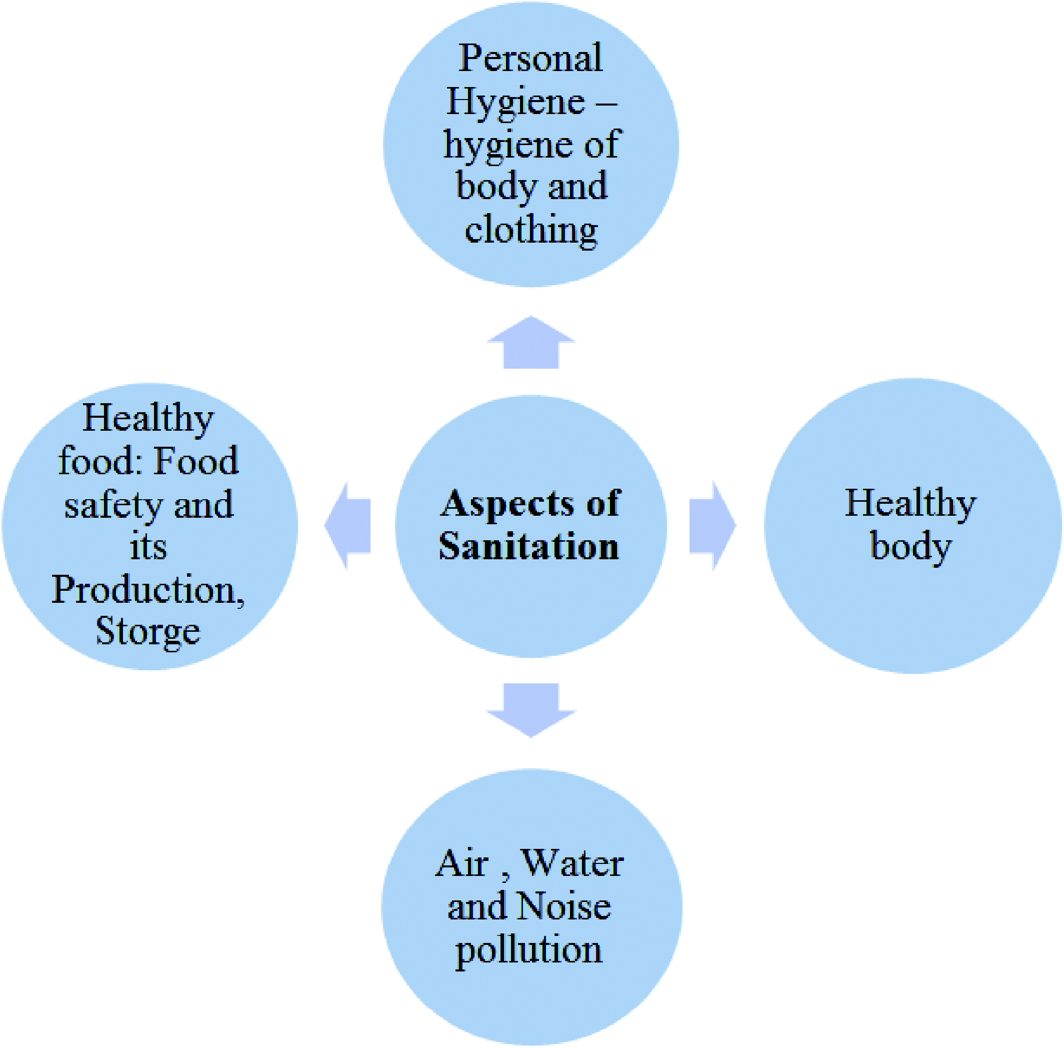


Fig. 25.4: Aspect of Sanitation

For example, preventing human contact through face masks is part of sanitation. Cleaning hands before eating, taking bath every day, and proper hand washing have to follow the basic hygiene and sanitation in our daily life.

Notes

INTEXT QUESTIONS 25.1

1. Fill in the blanks

   i. ....Is the level of functional condition of a person's mind and body?

   ii. World Health Day is celebrated on ....

   iii. .... is a product of interaction among the agent, host and environment.

   iv. .... refers to the set of practices associated with the preservation of health like personal hygiene, household cleanliness, and community cleanliness.

   v. Human Health is intimately linked to the state of the ....

25.2 LINKAGES BETWEEN ENVIRONMENT, HEALTH AND SANITATION

You know that, if we live in better environmental conditions we will have higher life expectancy than those who live in a polluted environment.

Both Environment and human health are inseparable. So, the environment should be kept clean and healthy to keep us healthy. After the industrial revolution, the world population transferred from rural areas to urban areas. It brought a huge problem which threatened our environment. This is mainly due to industrial activities along with rapid growth of population. Large population is responsible for lower quality of life, growth of slums and other associated problems like poverty and inequality, technical and scientific development while industrial activity produces industrial waste.

Industrial waste produces three kinds of waste; solid, liquid and gas. Industrial waste pollutes the nearby soil or adjacent water bodies and can contaminate groundwater, lakes, streams, rivers or coastal waters. Industrial waste is often mixed with municipal waste, making accurate assessment difficult.

Industrial waste includes trash, oils, solvents, dust gravel, many harmful gases etc. These are dumped in seas or land without adequate treatment, thus becoming a source of pollution. In areas of poverty (malnutrition), inadequate medical services, poor sanitation, and substandard housing prevail. It is difficult to identify the specific effects of malnutrition on people's susceptibility to disease because so many other factors are present. Direct damage has to health and health determining sectors such as agriculture, water and sanitation. Climate change is the single biggest health threat facing humanity. Health professionals worldwide are already responding to the health harms caused by this unfolding crisis.

Human Health is intimately linked to the state of the environment. Good quality natural

environments provide basic needs, in terms of clean air and water, fertile land for material inputs and food production and energy, and forests also serve to regulate climate. At the same time the environment represents an important pathway for human exposure to polluted air, noise and hazards, chemicals etc. Healthy people are those who live in a healthy house on a healthy diet of quality environment.

Since last century environmental degradation has increased as the human population has been increasing. Many indicators of growth and development like agricultural progress, rapid growth of urbanisation, and industrialization. The relationship between the health of the human population and the state of development of a society is complex and varies over time. Good health is a result from complex interaction between man and agent and the environment. If you are living on a busy main road, very close to a source of electromagnetic radiation or near a site of disposing of hazardous waste, you may be more at risk of illness than others who do not live. For example, many areas of Bihar, west Bengal are prone to health hazards due to the consequences of consuming Uranium, Arsenic, Fluoride and Iron through water and vegetables and food grains.

Let us discuss, elements of environmental health which focus on following

1. Global Environmental Health
2. Outdoor Air Quality
3. Surface and groundwater
4. Toxic substances and Hazardous wastes
5. Home and Communities
6. Infrastructure and Surveillance

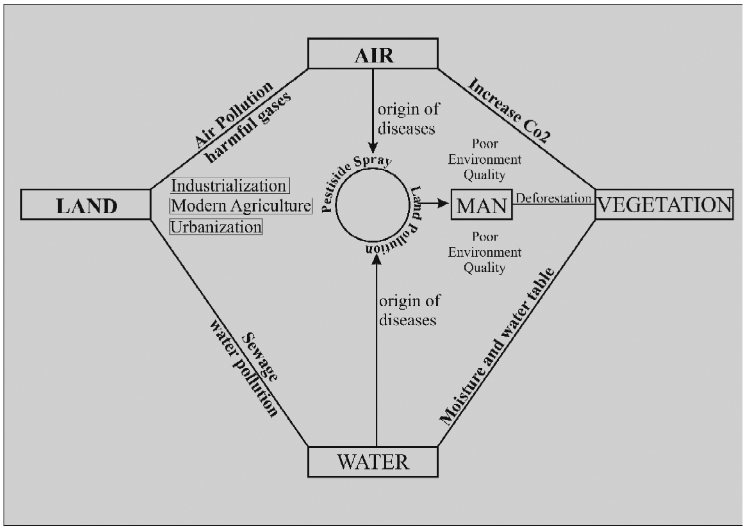


Fig. 25.5: Linkages between Environment health and sanitation

Notes

There are following important driving forces which are interlinked in environment health and sanitation processes.

A. Modern Agriculture

Agriculture is a primary activity and the base of any country's development. This is fully based on our environment. All other types of economic activity are directly or indirectly related to agricultural activities. It is a main source of food and nutrition for human beings. Development in this sector has positive as well as negative impact on human health. Health can be a result of under nutrition as well as over nutrition. The excess use of fertilisers or pesticides for higher production has been linked to the elevated incidence of human diseases such as cancer, asthma, obesity, respiratory disease and organ system failure and the risk of groundwater problems in the human population. Pesticides like DDT, DDE, TDEetc. have their impact on all three components of earth i.e. lithosphere, hydrosphere and atmosphere. Pesticides can even enter the body through skin, lungs and digestive tract. Many Diseases can be seen like nausea, vomiting, abdominal cramps, diarrhoea and gastro-intestinal poisoning.

B. Industrialisation

industrialisation means increasing the establishment of industries which in turn has an impact on the environment. Forests are cleared to make way for new industries and cutting of trees causes many harmful impacts on human health and environment. With an expansion in human population more food, materials and shelter are being manufactured at stupendous rates, mostly stemming from forestry. Trees are very important for humans and the environment because they release oxygen and make the environment clean. Industries are continuously polluting indispensable resources like air, water and soil which require millions of years to replenish. In other words, due to industrialisation pollution increasing in rivers and water bodies and in air smoke release everywhere. These pollution and cutting trees affects the environment and causes harmful effects on human health. It also causes diseases like asthma because without trees humans face problems in breathing.

C. Urbanisation

Urbanisation led to migration from rural to urban areas leading to overpopulation and overcrowding thus resulting in poor health practices due to congestion and development of slums.

D. Air pollution

Air pollution is a major threat to human health. The combustion of fossil fuels is the problematic and principal source of air pollution in the urban and industrial areas. Beside

Notes

its health impacts, air pollution also poses a threat to the region's food security, water security and climate system. Air pollution such as ozone and sulphur oxides cause crop and ecosystem damage and pose a major concern for food security. Black corban, a component of particulate matter, has been identified as a major contributing factor in the accelerated melting of snowpack and glaciers.

Polluted environment causes various types of diseases, for example infectious diseases are caused by internal dysfunctions such as autoimmune diseases. In a broader sense, disease is a condition that causes pain, dysfunction, distress, social problems or death to the person.

E. Climate Change

Global climatic change is an important issue that concerns mankind. You all know that the "Greenhouse effect"is due to anthropogenic activities which have destroyed the protecting layer of earth's temperature. Global warming is maintaining harmful effect on human health, animal, forest, wildlife, agriculture and water environment. It also adds health risk to poor people. Climate change affects elements of healthy environment as clean air, safe drinking water, sufficient food and secure shelter. Due to it's expected to cause additional deaths per years from malnutrition, malaria, diarrhoea and heat stress.

Climate change puts at risk the food supplies of people in developing and developed nations like flood, drought, more intense hurricanes, heat waves and wildfires can drive down crop yields, destroy livestock and interfere with transport of the food. Rising carbon dioxide levels from human activity can make staple crops nutritious like rice or wheat.

In most of the places where food is grown today, crop yields are likely to be lower because of more frequent heat waves, worse air pollution, floods and droughts. All essential nutrients for people's health represent major risks to people's health in developing nations where deficiencies in zinc, iron and protein lead to major burdens of disease. The diseases range from maternal mortality around child birth to problems with brain development in children.

Climate change influences human health and disease in numerous ways and may vary with location, time and economic base.

Table 25.1: Major pollutants/ contaminant/ wastes, sources and impact on health

Pollutant	**Sources**	**Impact on health**
Carbon monoxide	Automobiles due to incomplete combustion	Displaces oxygen in blood, reduces the amount of oxygen to blood tissues, extra burden on anaemic, heart and lung patients.

Particulates (Smoke, Fly, Ash etc.)	Stationary fuel combustion in industrial process	Occurrence of photo-chemical smog
Oxides of sulphur	Burning of coal and oil as fuel in industrial processes	Harmful for the respiratory system, irritates the upper respiratory tract and lung tissue.
Hydrocarbon	Automobiles, fuel combustion in electric power plants, combustion of solid waste disposal etc.	Help with farming photos - chemical smog.
Oxides of nitrogen	Burning of fuel at very high temperatures as in transport vehicles, power plants and industrial boilers.	Nitrogen oxides combine with hydrocarbons in the presence of ultraviolet rays of the sun to form secondary pollutants called photo-chemical oxidants.
Degradable wastes	Domestic and municipal sewage and other oxygen demanding industrial wastes	Depletion of dissolved oxygen in water , harmful for fish and other aquatic life.
Infectious agents	Polluted, stagnant water breeding grounds for parasites, bacteria, viruses of all kinds.	Cause water-borne diseases and outbreak of epidemics such as amoebiasis , dysentery, cholera, typhoid etc.
Synthetic organic compounds	Such as pesticides, agricultural chemicals, detergents, industrial wastes , DDT etc.	Instance of cadmium, lead and mercury poisoning in human beings. cause neurological impairment and even deaths
Inorganic minerals	other chemicals . Asbestos and acids etc.	Asbestos produces lung cancer. Acids cause allergies, ulcers, skin diseases. Also have a catastrophic impact on fish and aquatic life.
Radioactive elements	Wastes from nuclear power plant and	Potentially hazardous in the event of leakages and induce radiation related illness
Sediments	Soil and mineral particles	Reduce amount of sunlight

	washed into streams or water	available for marine plants cause clogging of filter plants
Thermal pollution	Water used for cooling in electric, thermal, nuclear power plants, when recirculate in water bodies	Can raise lake water temperature by 70-100 c aggravate diminution of dissolved oxygen, kills marine fish and plants life.

Other effects on health like temperature related illness, Extreme weather related effects, effects of food and water shortage, effects of noise pollution etc. Human health and its safety is also affected due to the unsafe environment at home, school and workplace as we spend most of our time in these places and may be exposed to conditions of indoor air quality, inadequate heating and sanitation, structural problems, electrical and power hazards and lead based paint hazards. Environment and health are closely associated with each other. Day by day, due to declining quality of environmental elements and their pollution level, health conditions are becoming worse. Along with this, many other issues like the threat of climate change, poverty, hunger and inequality are challenges for health, sanitation and environment for human survival. Without sound health, there is no meaning to life.

INTEXT QUESTIONS 25.2

1. Write T against the correct statement and F against the incorrect statement

   i. Without sound health, there is no meaning to life.

   ii. Pesticides do not have any impact on the components of earth.

   iii. Air pollution is not a major threat to human health.

   iv. Global warming is maintaining harmful effect on human health, animal, forest, wildlife,

25.3 GOVERNMENT INITIATIVES FOR SANITATION PROGRAMME

We know about these diseases which are a result of the polluted environment due to many anthropogenic activities. Sanitation and environmental quality are necessary requirements for human health. Passing a clean environment to the next generation is a critical aspect for each successive generation. Without safeguarding our environment, we can't keep our environment healthy. That's why our government, with the collective wisdom of all stakeholders, is thinking in terms of sustainable development and environmental management for the future generations.

All of us have a right to live in a quality environment. Environmental protection has become a global motive for all our development and planning. This can be achieved by environmental

Notes

management programmes, through various ways:

- Decreasing air pollution is an important step in order to create a pollution free healthy environment.
- Protecting water resources by minimising exposure to contamination are an important part of environmental health.
- Reducing exposure to toxic substances and hazardous wastes are a fundamental requirement for environmental health.
- Maintaining healthy homes and communities and free from hazards and unsafe conditions is essential for the safety of our health.
- Others such as to protect biodiversity, educate people to all levels; encourage research for formulating plans, policy and guidelines for the improvement of the quality of the environment.

The Indian government has started various programmes and initiatives towards sanitation, cleaning of rivers, poverty eradication and health facilities. In the present scenario we are over using the national resources and polluting our environment but to keep our environment clean and healthy government initiatives have played a huge role in helping out solutions to the problems.

"Sanitation is a cornerstone of public health" Dr.Margarreet Chan, Director- General, WHO

"Improved sanitation contributes enormously too human health and Well-being, especially for girls and women"

In this regard the following important initiative is going to be discussed.

A. Namami Gange Programme

The NamamiGangeYojana was a part of flagship programme initiated by the central government as an integrated conservation mission in 2014. The objectives of initiatives are conservation, rejuvenation, and effective reductions of pollution to clean the River Ganga. The total pollution level of river Ganga is contributed both ways i.e. domestic and industrial waste water and the non- point resources are agricultural sewerage, solid waste dumping left over religious material etc. The domestic sewage contributes 70 percent of the pollution load whereas industrial waste contributes to 30 percent of the all pollution loads. Under this programme emphasis has been given on pollution elimination, sewerage treatment infrastructure, river surface cleaning, afforestation, industrial effluents monitoring, biodiversity, and river-front developments, development of efficient irrigation methods and rational agricultural practices and public awareness. As per an estimate

everyday 500 million litter's wastewater from industrial services are directly dumped into rivers in many places. This programme is divided in entry-level, medium level and long term activities to be implemented within ten years. The Ministry of Drinking Water and Sanitation identified 1674 Gram Panchayats situated on the banks of the River Ganga in 5 States to construct toilets. A consortium of 7 IITs is engaged to prepare the Ganga river basin plan, and 13 IITs adopted 65 villages for developing them as model villages.

B. Swachh Bhrart Abhiyan

Swachh Bharat Abhiyan (SBA) is a country wide campaign initiated by the Government of India on 2nd October 2014. This mission was started with an aim to eliminate open defecation and open defecation free country in five years and construction of individual cluster community toilets. As we know open detection was one of the major causes of death of thousands of children's every year. The aim of this mission was changing people's attitudes, mind-sets and behaviours towards villages to be kept clean. It also encourages cost effective and appropriate technology for ecologically safe and sustainable sanitation facilities through awareness creation and health education.

Have you thought, Why SBA? Why on Gandhi Jayanti because Ghandhiji had rightly said (1923) "sanitation is more important than independence" he was aware of the pathetic situation of rural India and emphasised on cleanliness sanitation. Through this mission it was about bringing an improvement in the general quality of life in the rural areas. The main focus of the mission is on solid and liquid waste management for overall cleanliness of the rural areas. The mission aims to cover around 1.04 crore households, provide 2.5 lakh community toilets, 2.6 lakh public toilets and a solid waste management facility in each town. Under the programme, community toilets will be built in residential areas where it is difficult to construct individual household toilets.

The SBA campaign proved to be a great success. Within four years of the campaign the number of people detected in the open dropped considerably from 550 million to around 150 million. This abhiyan also includes operations like door to door waste collection and their proper disposal. In 1990 deaths due to water and sanitation consisted of 13 percent of the total death across the country. By 2016 the percentages had come down to 5 percentages; which is quite significant.

C. Ujjwala Yojana

The Ujjwala Yojana scheme is a big and path-breaking initiative regarding the health and sanitation of local women and the nation as a whole. It was started in 2016 by the Ministry of Petroleum and Gas, central government for transforming the lives of the poorest of the poor. The scheme PMUY (Pradhan Mantri Ujjwala Yojana) aims to

Notes

provide clean fuel to women and address health hazards due to use of wood, cow dung, free from drudgery of collecting firewood, smoke free house to all etc. in cooking. There was a target to achieve 8 crore households for LPG connection by 2020 and to be covered by 58% population by 2030. It is a greater push towards use of cleaner fuel because there are serious health hazards associated with the burning of fossil fuels. As per an estimate of WHO, 5 lakh people died in India due to the use of unclean cooking fuels. The smoke inhaled by women using nuclear fuel is equal to smoking lots of cigarettes in an hour. By which the air pollution causes respiratory disease or disorders like lung cancer, heart disease, stroke and chronic and obstructive pulmonary diseases

Some diseases are reduced through implementation of this Scheme. In the nation as whole and particularly local rural women are benefiting due to air pollution, clean environment and healthy society.

INTEXT QUESTIONS 25.3

Multiple Choice Questions

1. Namami Gange Programme was initiated in -

   a. 2012 b. 2013

   c. 2014 d. 2015

2. Swatchh Bharat Abhiyan was celebrated on -

   a. Buddha Jayanti b. Gandhi Jayanti

   c Mahavir Jayanti d. Ambedkar Jayanti

3. UjjwalaYojana is an initiative for -

   a. Children b. Men

   c. Women d. none

25.4 TRADITIONAL HEALTH CARE SYSTEM AND MEDICINAL PLANT

The concept of health has evolved over the centuries. Health care system is one of the important aspects of health. Worldwide, there are two types of medical health care systems: one traditional and the other modern. To provide all modern health care facilities to the citizens of a country is difficult especially for a developing country like India. Therefore, we have to use and focus on our traditional health care system. A number of traditional systems have existed and flourished across the world. The Indian traditional system is also known as the natural health

care system, for example Ayurveda, Naturopathy and yoga. Natural health care system is based on the philosophy of "nature is the best healer".

This system is fast disappearing due to relatively low income, lack of written documents, deaths of the knowledge bearers, lack of government strategy to protect their knowledge, among the present generation and overall impassive attitude towards traditional healing systems.

The UN SDG 3 focuses on good health. The need of the hour is to develop medicines combining modern medicines, yoga and traditional medicines for sustainable health.

Medicinal plant - we have to learn about medicinal plant uses and their important role in the primary health care system. In the urban areas need to aware of rich knowledge that exists in our traditional health care systems of medicine regarding usage of various plants species for our health care needs.

Many plant species used for medicinal purposes are also used in the field like aromatherapy , fragrance, essential oil , food supplement , herbal tea , cooling purpose, healing powers , and cosmetics purpose etc.

Medicinal plants today are seen only as a source of affordable health care in developing nations but also in the developed world. About 80 percent of the developing countries population uses indigenous medicines based upon plants. Most of the world population believes that local medicine systems based on plants have no side effects. India has strong traditions as a plant based system of medicine like Ayurveda and Siddha which are 3000-5000 years old.

Medicinal plant sector is highly unorganised where traditional healing is often seen as an unrecognised occupation. The large number of healers belong to the poor and aged group. Many medicinal plants have significantly contributed to the maintenance of the health and fitness of masses since ancient times and remain to do so in most of the developing countries even today.

Some examples are mentioned in the following table:

Table.25.2. Information of important Medicinal plants and its health benefits

Plant Name	Used Part	Health benefits
Ashwagandha	Roots	Reduce stress and tension, control depression, useful in general weakness and gives vitality.
Amla	Fruit	Rich source of vitamin C, useful indigestion and Jaundice, it cures insomnia and is healthy for hair , it is used as Cardio protective
Arjun	Bark	Mainly used in heart disease and it helps strengthen

		the body's natural rejuvenate processes, hastening the replacement of dead or weak cells with fresh, vital ones. the bones,
Ashok	Bark, Seeds and flowers	Bark used in biliousness, dyspepsia, fever, ulcer, dysentery, colic, piles and pimples. Dried flowers used in diabetes and hemorrhagic dysentery, seed used for treatment of bone fractures.
Brahmi	Whole plant	It is an excellent brain tonic, useful for nerves and used in mental diseases, used to improve intellect, treatment of asthma, hoarseness, insanity and epilepsy.
Bahera	Fruit and Bark	Fruit is useful in stomach disorders such as indigestion, diarrhoea. It is useful in asthma, bronchitis, inflammation, sore throat, and treatment of eyes, nose, heart and bladder diseases.
Bael	Fruit, leaves and root	It is a tonic, antibiotic and appetiser, used in the treatment of constipation. Fruit juice is beneficial during summer.
Bach	Rhizomes	It is valued as a rejuvenator for the brain and nervous system and as a remedy for digestive disorders. SUseful in stomach aches and kidney stones.
Gwarpatha	leaves	Leaf pulp used in liver and spleen ailments and for eye troubles, also used in colic and constipation, skin disorders, burns , anti - ageing creams and cuts.
Jamun	Seed and Bark	It is traditional medicine for diabetes and sore throat, seed powder and juice is used for diabetes, Bark used in dysentery and leucorrhea.
Kadipatta	Whole plant, leaves and root bark	Diarrhoea, dysentery, piles, leukoderma, blood disorders.
Shatavari	roots	Used as a general tonic,, useful in nervous disorders, tumours, throat infections, cough, bronchitis and general debility.

Sarpagandha	roots	Root is used as a sedative and for reducing blood pressure, also for relief from nervous disorders including anxiety, insanity, insomnia and epilepsy.
Sadabahar		Leaves, flowers, root Infusion of leaves used in diabetes and decoction of roots is used for hypertension, sedation and in toothache; extract of leaves is anti- carcinogenic.
Tulsi	Leaves , seeds	Widely used in Cough, cold and fever. It possesses anti-fungal, antimicrobial, antiviral, insecticidal, activity. It is used in malaria, bronchitis and gastric disorders, it also lowers blood sugar levels.

Government of India launched National Natural Urban Health Mission of AYUSH for better urban health and wellbeing. The Ministry of AYUSH (Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homeopathy) is responsible for reviving the knowledge of the traditional health care system.

Environment balance is a must for the health of man and his environment, and then we can achieve sustainability of the planet earth. When we save our environment from the impact of various types of pollution and give priority to sanitation in daily life, then we will be able to live in a healthy environment and our body will also become healthy.

INTEXT QUESTIONS 25.4

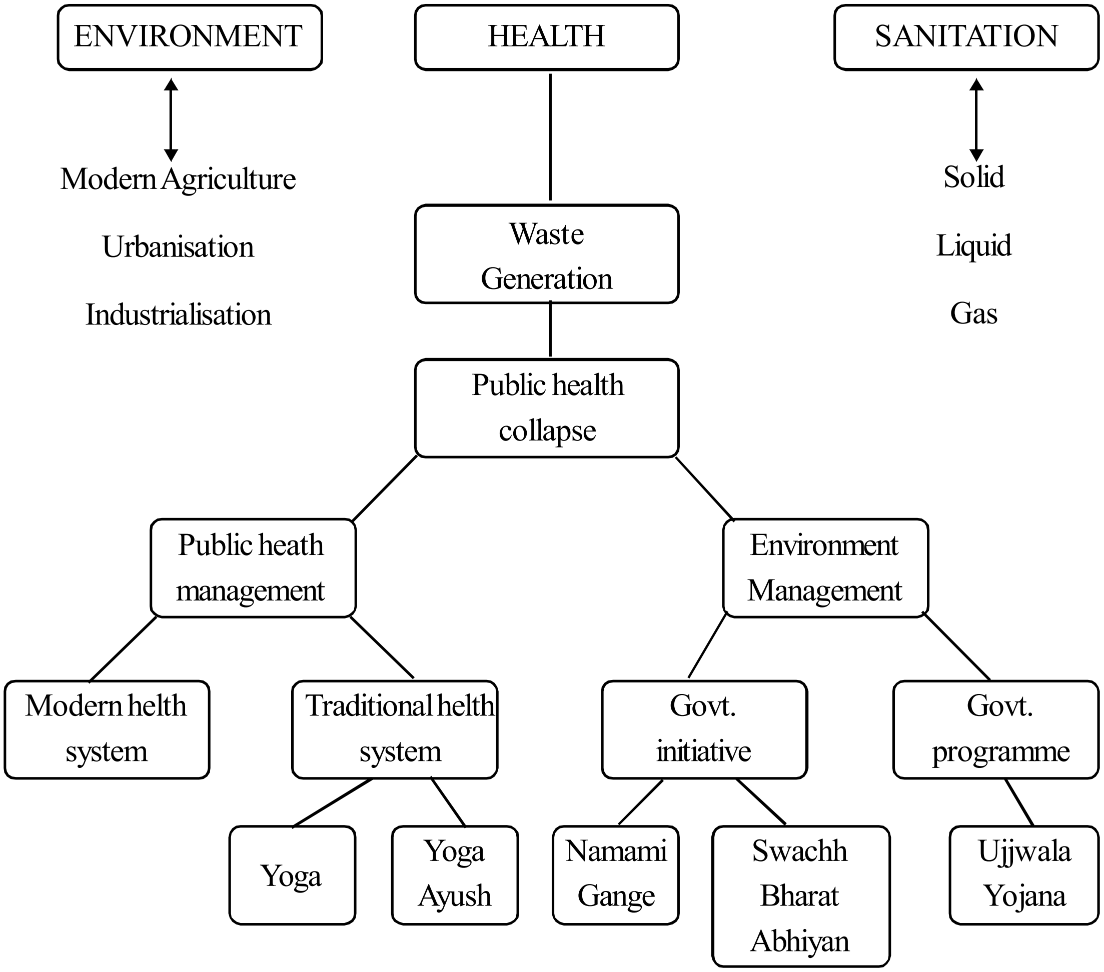
Match the following-

a.	Ashwagandha	i.	Ayurveda
b.	Brahmi	ii.	Stomach disorder
c.	Traditional Health Care System	iii.	Reduce Stress
d.	Bahera	iv.	Brain tonic

ACTIVITY

1. Visit a nearby herbal garden / Park and make a list of the medicinal plants and its utility.

WHAT YOU HAVE LEARNT



TERMINAL QUESTIONS

1. Which one is correctly matched?

   i) Sanitation is more important than independence - Mahatma Gandhi

   ii) "Sanitation is a way of life." - Dr.Margarreet Chan, Director- General, WHO

   iii) "Sanitation is a cornerstone of public health - According to National Sanitation Foundation of the USA

Notes

2. Define Health and explain its 3 specific dimensions.

3. Write about 5 elements of the environment, why it is important for us.

4. How modern agriculture practices are responsible for various health issues.

5. What is Environmental Sanitation?

6. What do you understand about agents of diseases?

7. Elaborate linkages between various aspects of the Environment. Health and Sanitation with the help of a diagram.

8. Make a list of various types of pollutants which are harmful to our health.

ANSWERS TO INTEXT QUESTIONS

25.1

(i.) Health

(ii.) 7th April

(iii.) Disease

(iv.) Hygiene

(v.) Environment

25.2

(i.) True

(ii.) False

(iii.) False

(iv.) True

25.3

(i.) 2014

(ii.) Gandhi Jayanti

(iii.) Women

25.4

(a.) iii.

(b) iv.

(c) i.

(d) ii.

Notes